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THE CONDOR

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THE CONDOR

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1960

LESSER TREE-SWIFT
HEMIPROCNE COMATA
From a painting by G. M. Henry

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THE CONDOR

VOLUME 62 JANUARY-FEBRUARY, 1960 NUMBER 1

GEOGRAPHIC VARIATION IN THE LESSER TREE-SWIFT

By KENNETH C. PARKES

The Lesser Tree-swift (*Hemiprocne comata*), as the name suggests, is the smallest of the three species of the Indo-Malaysian family Hemiprocnidae. These beautiful birds are variously known as tree-swifts, crested swifts, or whiskered swifts. The shortest of these vernacular names, adopted here, calls attention to the habit of tree-perching, one of the characters distinguishing the family from the true swifts (Apodidae). Wetmore (1951:7) has commented on the proposal by a few authors that the tree-swifts be reduced to subfamily rank. The species *Hemiprocne comata* is found from southern Tenasserim, Burma, southward through the Malay Peninsula to Sumatra, Borneo, and numerous smaller islands of the East Indies, and in the Philippines. A number of names have been applied to various populations of this species; in chronological order, and with type localities noted, these are as follows:

Cypselus comatus Temminck, 1824 (Sumatra).
Macropteryx comata major Hartert, 1895 (Luzon).
Hemiprocne comata nakamurai Hachisuka, 1930 (Samal Island, off Davao, Mindanao).
Hemiprocne comata stresemanni Neumann, 1937 (North Pagi Island).
Hemiprocne comata barbarae Peters, 1939 (Bayog, Naujan, Mindoro).

Peters (1939:95) appears to be the only author who has used all of these names for five supposedly valid subspecies. Mayr (1945:110) and other recent authors have reduced these to two. According to Mayr's concept, a large race, *major*, inhabits the northern and central Philippines, while the nominate race *comata* is found in the Philippines from Mindanao southward, as well as in the remainder of the species' range.

The two principal characters which have been used in defining subspecies of *Hemiprocne comata* have been size (the only character admitted by Mayr) and the color and relative amount of gloss of the back and underparts. In his key to the races, Peters (1939:95) also mentions a difference in the amount of white on the abdomen and in the shade of chestnut on the auriculars of males in separating *nakamurai* and *stresemanni*.

There is undeniably a size cline running from north to south in the Philippines, with the largest specimens coming from northern Luzon and the smallest from Mindanao, Basilan and the Sulus. The cline is apparent even within the island of Luzon itself. Wing measurements, partly compiled from the literature, are as follows (sexes alike in size):

Northern Luzon	140, 146.5
Central Luzon	136.5, 137, 140, 140, 140, 140.5, 141, 143
Southern Luzon	134, 135.5, 138, 138.5, 139
Mindoro	133, 137, 137, 137.5, 138, 138, 139, 139, 141, 144
Negros	138, 140, 141, 144
Mindanao	123, 127, 129.5, 131.5, 132, 134, 134.5, 136, 139
Basilan	124, 125, 132, 135
Sulus	125+ (worn), 129, 130

Zimmer (1918:224) long ago mentioned the large size of certain specimens from Mindanao supposed on geographic grounds to be referable to *comata*. In view of the

great overlapping of measurements and the clinal nature of the variation, there is little to be gained by continuing to attempt to define two subspecies of *Hemiprocne comata* within the Philippines on the basis of size. If a line is drawn north of Mindanao (the usual division between *comata* and *major*), fully 46.6 per cent of the specimens from the Philippines examined would fall within the zone of overlapping measurements and could be named only by reference to locality of origin.

Two races, *nakamurai* Hachisuka and *barbarae* Peters, have been named from the Philippines primarily or solely on the basis of color characters. Hachisuka (1930:172) claimed that the back and underparts of *nakamurai* were "more strongly tinged with green than the typical *major*," and Peters described *barbarae* as greenish rather than bronzy. My examination of specimens supports Mayr's contention (1945:110) that

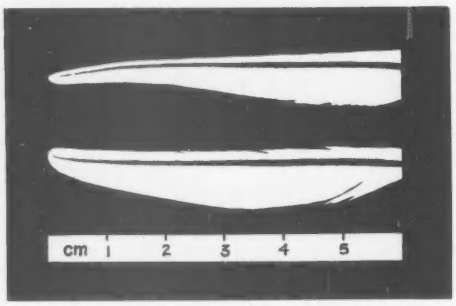

Fig. 1. Outer tail feathers of *Hemiprocne comata*. Illustrations prepared from direct impressions of feathers on photographic paper.

Upper, *H. c. comata*, A.M.N.H. 634407, Padang, Sumatra.

Lower, *H. c. major*, Carnegie 137032, Wawa, Luzon, Philippines.

relative greenness or bronziness of the plumage is directly correlated with degree of wear and is valueless for definition of geographic variation. As for the auricular color of males, Ripley and Rabor (1958:44) show quite correctly that this is subject to much individual variation, and, I may add, to fading with wear. Neither size nor color, therefore, supports recognition of more than one race of *Hemiprocne comata* within the Philippines.

Mayr (1945:110) considered birds from the southern Philippines inseparable from true *comata* of Sumatra. In this opinion he was supported by de Schauensee (1957:7), who considered three Mindanao specimens "identical with Sumatran examples." Since size is said to be the only valid character differentiating *major* and *comata* (Delacour and Mayr, 1946:130), and since, as shown above, no useful separation by size can be made in the Philippines, it would appear that the name *major*, too, would have to be suppressed, and we would end up with a monotypic species.

This is by no means a true interpretation of the actual situation, since the most important geographically variable characters have been overlooked or underestimated in the past. The Philippine population as a whole differs markedly from all other *Hemiprocne comata* in a striking structural character which has never been mentioned in the literature. In all specimens from the Philippines the rectrices are broad, and the outer-

most gradually tapers to a relatively blunt end. In nominate *comata* the rectrices are narrow, and the outermost is greatly attenuated (fig. 1). Although the degree of attenuation varies to some extent within *comata* (the figured specimen is by no means extreme), the difference between the rectrices of specimens from the Philippines and all others is clear-cut. By the standards of an earlier school of taxonomy, *major* would undoubtedly have been given specific rank on the basis of such a character; specimens from Sibutu Island, Sulus, and Sibattik Island, North Borneo, less than 120 miles apart, have tail shapes completely typical of *major* and *comata*, respectively. However, specimens from the Sulus do show an approach to *comata* in another character, as will be mentioned beyond.

Mayr (1945:110) mentioned a supposed difference in extent of white on the abdomen only to deprecate it, but it is a perfectly good character. Examination of the specimens in the collection of the American Museum of Natural History indicates that Mayr may have been misled by the great extent to which preparation techniques affect the superficial appearance of the abdominal region of these tree-swifts. All specimens from the Philippines have a clearly-defined area of white on the lower abdomen, with a slight tendency toward decrease from north (Luzon) to south (Mindanao and Basilan). Specimens from the Sulus are intermediate between *major* and *comata* in abdominal color, but they are referable to *major* on the basis of tail shape. The subspecies *comata* is characterized by having white on the under tail coverts only, not on the abdomen. In some specimens there is a certain amount of concealed white in the center of the posteriormost abdomen, but there is never a large clearly-defined patch as in *major*. White areas other than the abdomen, including tertials, chin, superciliary line, and crest, also average more extensive in *major* than in *comata*.

Within the range here assigned to *comata*, certain geographic trends in variation appear. Neumann (1937) described *stresemanni* from North Pagi Island in the Mentawi group on the basis of alleged differences in dorsal color; this is attributable to degree of wear as mentioned previously. Examination of a good series from North Pagi and other west Sumatran islands indicates that birds from this area do not differ from *comata* from Sumatra except for a slight tendency toward an increased amount of concealed white in the abdominal region. I follow Ripley (1944:355) and Mayr (1945:110) in synonymizing *stresemanni* with *comata*.

Specimens from northern Sumatra average larger than those from other populations of *comata*, but overlap is extensive. Wing measurements are as follows:

Northern Sumatra (21 specimens)	125–136 (av. 129)
Southern Sumatra	123.5, 125, 125
West Sumatran islands (18 specimens)	120.5–130 (av. 126.3)
East Sumatran islands (Bintan, Lingga, Sinkep)	125, 126.5, 128, 129
Malay Peninsula	122.5, 124, 125
Borneo (10 specimens)	119–130 (av. 123.8)

There is great individual variation in tail length in *comata*, correlated neither with sex, age, nor locality. There may be as much as 16 mm. difference in tail length between two adult males from the same locality. As in the case of *major*, then, no further subdivision of *comata* appears to be warranted on the basis of either size or color.

In summary, the two recognizable subspecies of *Hemiprocne comata* may be defined as follows:

Hemiprocne comata comata (Temminck). Synonym: *stresemanni* Neumann. Malay Peninsula, Sumatra, Borneo, and various smaller islands (for details see Peters, 1940:258). Averages smaller (wing 119–130 mm., specimens from northern Sumatra to 136 mm.); rectrices narrow, the outermost

greatly attenuated; white of abdomen much reduced or absent; white on tertials and chin reduced. 64 specimens examined.

Hemiprocne comata major (Hartert). Synonyms: *nakamurai* Hachisuka, *barbarae* Peters. Philippine Archipelago (apparently absent from Palawan). Averages larger, particularly in the north (wing 123–146.5 mm.); rectrices broad, outermost gradually tapered; large white patch present on lower abdomen; more white on tertials; white on chin more extensive; white superciliary line and crest averages broader. 32 specimens, including type, examined.

Acknowledgments.—I am grateful to the authorities of the American Museum of Natural History, the Academy of Natural Sciences of Philadelphia, and the United States National Museum for use of specimens. Carnegie Museum specimens were taken in the course of a Philippine expedition of the Graduate School of Public Health, University of Pittsburgh, under the sponsorship of the Commission on Viral Infections, Armed Forces Epidemiological Board, which was supported in part by the Office of the Surgeon General, United States Department of the Army. The figure was prepared by Clifford J. Morrow, Jr.

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Carnegie Museum, Pittsburgh, Pennsylvania, April 20, 1959.

BEHAVIOR OF THE INCA DOVE

By RICHARD F. JOHNSTON

INTRODUCTION

The Inca Dove (*Scardafella inca*) is a small, ground-foraging species that occurs from the southwestern United States through México to northern Costa Rica. Observations of wild Inca Doves in southern Dona Ana County, New Mexico, Travis and San Patricio counties, Texas, and southern Sonora, México, form the basis for this report. These doves are notable for their apparent preference for living in modified urban parkland. Thus it is that three of the populations referred to in this paper occurred on the campus of New Mexico State University, in the suburbs of Austin, Texas, and on the grounds of the Welder Park Zoo, Sinton, Texas. In New Mexico, in areas used by Inca Doves, vegetation other than agricultural crops consists of introduced, broad-leaved deciduous trees and exotic conifers, and in Texas such areas have as dominants the native live oaks; there is in any such area relatively little understory vegetation.

The Inca Doves in Sonora maintained a breeding population near Alamos along a small stream, the Río Cuchujaqui. The vegetation there is composed of various short-tree woodland elements, mainly legumes and figs (see Gentry, 1942), and of certain riparian dominants such as bald cypress (*Taxodium mucronatum*) and occasional sycamores (*Platanus*). Open ground and broken understory have been created along the flood plain of the stream by direct and indirect human activity and it is, characteristically, in association with such areas that Inca Doves are found.

Behavior on the periphery of the range of the species, as in New Mexico, may differ from that in non-peripheral areas. Between any two such areas, breeding and territorial behavior probably differ less than other kinds of behavior. However, behavior in autumn and winter does vary between the New Mexican and the more southerly areas. Geographic variation in behavior will thus be emphasized in the discussion when it is appropriate.

I thank Dr. John William Hardy, Mrs. Lora Lee Johnston, Mr. James Morris, Dr. Ralph Raitt, Dr. Gerhard A. Schad, and, particularly, Dr. Robert K. Selander for assistance in the field. Dr. Robert M. Mengel contributed the drawings. Partial financial assistance was received from the Permanent Science Fund of the American Academy of Arts and Sciences and the Kansas University Endowment Association. Dr. Clarence Cottam, Director of the Welder Wildlife Foundation, Sinton, Texas, graciously extended to me use of housing and laboratory facilities at the Foundation.

The narrowness of total range in kinds of behavior in Inca Doves is particularly evident in the nonbreeding season, when the apparent energy output by these birds is considerably below that of other kinds of birds living nearby. At such times the activities of icterids particularly point up the general poverty of overt motor activity in Inca Doves, but most other kinds of birds also show a greater range in activities than do these doves. Likewise in the breeding season Inca Doves exhibit a restricted range of ritualized courtship behavior; relatively few stereotyped actions are necessary for effecting formation and maintenance of the pair bond.

Only in the hostile aspects of territoriality can the Inca Dove be said to show a "vigorous" set of behavioral patterns. Indeed, it is this aspect of the birds' behavior that has attracted the most attention in the past and which is responsible for the idea that Inca Doves are aggressive, hostile, and "vigorous" birds.

The matter of "restricted" behavior will not be stressed in the material to follow; it is mentioned here partly to emphasize that the following account is a fair delineation

of major aspects of behavior in these doves and partly to suggest the nature of some of the problems involved in attempting to understand the derivation of certain behavior patterns. It is never clear, of course, whether elements of a derived behavioral gestalt faithfully reflect a precursor condition or whether elements of a precursor condition have been dropped in the derived behavior.

Flight.—The beat of the wings is strong and rapid in Inca Doves, and in straight-away flight their appearance is clean and trim. Short flights of a few feet or yards are jerky; the wing beat is irregular and the long tail is fanned and contracted and swung up and down and back and forth as the birds move at slightly over stalling speed.

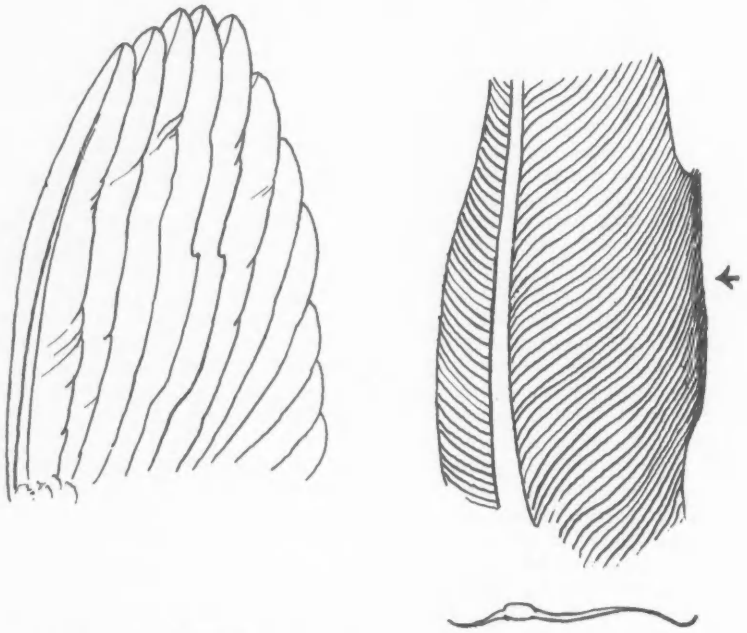

Fig. 1. Underside of wing and primary 8 of an Inca Dove (KU 34901). The diagram shows the emarginations are a function of relative spacing and differential lengths of the barbs. Drawing by R. M. Mengel.

In flight the remiges cause a characteristic sound of flat, buzzing quality. This sound is heard easily for 20 to 30 yards. In my experience only the Ground Dove (*Columbigallina passerina*) makes a sound similar to this. The quality of this wing-beat sound is probably a function of emarginated trailing edges, which both species have on certain primaries; adult Inca Doves have them on primaries 7 and 8 (fig. 1) and Ground Doves have them on primary 8 only. It is significant that the sounds differ slightly in the two species, and this indicates a reasonable functional significance of the sounds, that of species advertisement.

It seems unlikely that the flight sound functions as a "warning" signal for group

flight or other escape behavior. Juvenal Inca Doves have this emargination on primary 8 only (primary 8 only in the Ground Dove), and they make less noise than do adults. Thus, their contribution to "warning" other doves would be minimal. But also, if the sound signal is one of species advertisement, the contribution of the juveniles might reasonably be minimal, for the young birds are relatively unimportant in the sociality of adult breeding interactions. The "adult" condition of the primaries is reached by almost all juveniles in the postjuvenal molt. Similar emarginated primaries are found in the other species of *Columbigallina,* in *Claravis* and *Columbina,* and in the African *Tympanistria.*

Foraging.—Inca Doves forage on the soil surface, taking small seeds of a wide variety of plants. Wheat, cracked corn, oats, and milo are taken readily if available, but the naturally occurring seeds the doves eat are almost always much smaller than these. The doves whisk their bills in dry soil, sending up small puffs of dust at each swipe and uncovering seeds previously hidden in the soil surface. Ordinarily three or four swipes are made in succession, after which the birds pick up whatever they uncover. Rock Doves (*Columba livia*), Mourning Doves (*Zenaidura macroura*), Ground Doves, Diamond Doves (*Geopelia cuneata*), and perhaps a majority of the Columbinae also forage in a similar manner in dry soil. Foraging on moist surfaces involves no swipes of the bill.

Vocalizations.—Inca Doves produce but four kinds of vocal sounds. These are:

1. "Song" (syllabically, *coo-coo*). This call is given both in the breeding season and in the time the birds are in groups. The responses of other doves at these two periods are different, and they will be taken up under appropriate headings later.

2. Aggression call (syllabically, *cut-cut-cut-ca-dóah*). This is discussed beyond under considerations of territoriality.

3. Courtship call (syllabically, *cut-cut-ca-doah*). This is discussed under considerations of courtship behavior.

4. Alarm note (syllabically, *cut*). This note is relatively "soft" in quality. One such note is given each second or two, usually for a short time, in response to apparent stress; as far as I know this has always consisted of my presence near the birds. This kind of note is difficult to locate in the field, for it has a nearly imperceptible beginning and end; this is obviously adaptive in that the bird does not automatically reveal itself to what has alarmed it. Andrew (1957:35) thinks this kind of note in buntings (Emberizinae) expresses "strong fear"; "weak fear" in buntings seems to be expressed by a more explosive note, one that has social communication value. In Inca Doves, the alarm notes probably are an expression of "weak fear"; they seem to express "strong fear" by flying away from its source; these doves are much stronger flyers than are buntings and it is reasonable to assume that they have a different orientation to strong stress situations.

Dispersal.—Little information is available on the dispersal of Inca Doves. The species is resident wherever its populations exist and presumably the young-of-the-year undertake dispersal; such movements would therefore occur in autumn and winter. Extralimital vagrancies that seem to be instances of dispersal have been recorded in autumn (Corona, California, Audubon Field Notes, 1955, 9:56; Boulder City, Nevada, Audubon Field Notes, 1953, 7:30), spring (Mesilla Valley, New Mexico, 1935, Harry G. Williams, MS), and winter (Harvey County, Kansas, 1951–52, Tordoff, 1956; Meade County, Kansas, 1956–57, Hardy, 1958; Ponca City, Oklahoma, Audubon Field Notes, 1957, 11:48). The record for Meade County, Kansas, is supported by a specimen (KU 33241); it is a bird-of-the-year. It is probably also meaningful that the only Inca Doves I ever recorded at my house two miles north of New Mexico State University were present in late August, for only two days, and at least one of the two individuals was a juvenile.

BREEDING BEHAVIOR

COURTSHIP AND NEST BUILDING

Courtship behavior is here considered to involve those activities that lead to the formation of the pair bond and to behavior tending to maintain that bond. In New Mexico by late January vocalizations of Inca Doves increase in frequency; this is the sign of incipient breeding behavior. Clear attempts at pair formation follow. Males do not seem to recognize females at sight (the species is not sexually dimorphic) but by their responses to certain ritual behavior. Displays seen at this time are not qualitatively different from those seen later, but they are of lower intensity: they are given for short periods, they are interrupted or may be incomplete for any of several reasons (some of which may not be apparent to an observer), males frequently seem to have no organized plan of behavior toward a specific female, and females regularly ignore the occasionally strong displays of males. By early March some pairs are established, but usually it is not until the end of March that the bulk of the population is arranged in pairs. Thus, it is in March, or in April in years having heavy rains and low spring temperatures, that definitive courtship display may be seen. Following this time, that is, after sex recognition and formation of the pair bond, the full range of epigamic behavior is rarely seen. Maintenance of the pair bond is accomplished with considerably less activity and fewer displays.

In Sonora early phases of courtship probably occur somewhat later in the year, for the birds there breed primarily near the inception of the rainy season, which on the average is in late June. Courtship patterns typical of birds not yet nesting were seen on June 7, 1957, in which year the rains began in late June. But, by June 4, 1958, most Inca Doves had already built nests and no courtship behavior was noted for any of the mated birds watched; 1958 had a prolonged occurrence of light spring rains and vegetation came into leaf about one month early. Probably doves respond to the timing of the growing season in Sonora in a fashion similar to their response in New Mexico.

Head bobbing.—Shortly after the increase in calling activity male Inca Doves engage in a bobbing ritual. This display consists of birds raising heads high on moderately extended necks followed by an abrupt downward movement of the heads and necks; the bill is maintained in a nearly horizontal position, and the action is repeated many times in a single display. Males bob at females or other males early in the season. Later, by a few days or a week, females reciprocate, and this seems to be an important part of sex recognition. Males almost never bob in return to another male.

Head bobbing bears a close resemblance to a notable sign of anxiety in Inca Doves. The birds make use of what appears to be a form of rapid-peering when they are under stress. In this action the head is moved from one position to another vertically above or below the initial position; a short arc is described by the head, as the movement involves in midcourse a slight rearward shifting. The movement is initiated either when the neck is extended or shortened, but in either case the action is repeated several times over and the head is moved up and down similarly to epigamic bobbing. If males are in fact under conflicting drives, as of attack and escape, early in the season, it is reasonable to think that epigamic bobbing could be a ritualization derived from an anxiety signal.

Mutual preening.—Bobbing is usually followed by preening of head and neck feathers of females by males. Females eventually preen in return. Similar activity in Rock Doves has been termed "nibbling" or "heteropreening"; it is advisable to use "mutual preening" with Inca Doves, first to emphasize that both males and females are involved and second to distinguish it from the similar behavior of Rock Doves. It is not the

earliest expression of epigamic activity in Inca Doves, whereas it probably is the earliest in Rock Doves. Also, in the latter it is often discontinued after pair formation, but in Inca Doves it remains one of the most characteristic features of the entire period of breeding.

Mounting.—This behavior occasionally precedes any of the stereotyped activities just outlined; it involves males standing on the backs of females and, ordinarily, attempts at copulation by the males. Copulation is probably almost never effected, however, since females at this time regularly ignore the presence of males on their backs, even to the extent of continuing foraging while the males attempt to maintain balance. Two birds early in the season may associate in this manner for five to ten seconds and then spend up to two minutes preening each other; yet after this they frequently part and never again associate with one another. However, such breakups probably become less frequent as the season advances, and mounting would seem to be integral in pair formation.

Mounting is also important in sex recognition. A mounted male actively rids himself of the bird on his back, but, as has been noted, a female is ordinarily passively tolerant of the mounter, even though she may show no tendency to behave sexually.

Up to this point in New Mexico most of the displays will have taken place in winter flocks; pairs leaving the flocks do so gradually through time and come to live in the parkland areas of the campus to breed. A considerable amount of time is required for the whole of the wintering population to assort into pairs and leave the flocks. Thus, at one point in the spring, birds in "winter" flocks, birds showing early epigamic display, recently-paired individuals, early territorial pairs, and pairs with nests and eggs can be found in various places on the campus. There is a difference in the ages of the differently-behaving birds: adults pair and leave the flocks earlier, and immatures remain longer in the wintering flocks. Later breeding of immatures than of adults in the same population has been documented in other kinds of birds, and it is not especially surprising to find this in the Inca Dove. Specimens have been taken to support this conclusion in the present study, but the bulk of the observations are of birds in the field. In Inca Doves the postjuvenal molt is mostly incomplete in the remiges; the eleventh primary, and occasionally the eighth through the tenth remain. Such feathers have a buff-white leading edge, which is lacking in the adult feather. Under favorable conditions these "white" primaries can be seen, in the closed wing, for at least 20 yards with 6×30 glasses.

Vertical tail fanning.—One to two weeks after the activities just described are evident in the population, and after pairs are on breeding territories, more intensive displays appear. Vertical tail fanning by males (fig. 2) is characteristic at this time. Males assume a horizontal posture one or two feet from females and face them. Tails are then elevated to a nearly vertical position and fanned; the black-and-white markings on the outer tail feathers are given prominence by this action. Males give a characteristic call in this posture; it may be rendered, *cut-cut-ca, doah.* It is a soft, throaty call; it carries poorly and is intended clearly for the female a short distance away. The complex of behavior associated with tail fanning by males probably serves to bring females more nearly into breeding readiness. Females participate little in response to this display, although females preen males whenever they come close. But about a week subsequent to the appearance of tail fanning nest building activity is initiated.

After first nestings are begun, full courtship display wanes. The pairs become involved with low-intensity displays only. Head bobbing is a continuing activity and mutual preening occurs until the end of the breeding season. Bobbing and preening seem thus to be primarily related to the establishment and maintenance of the pair bond, and therefore only secondarily related to sexual behavior as such, but they serve as a be-

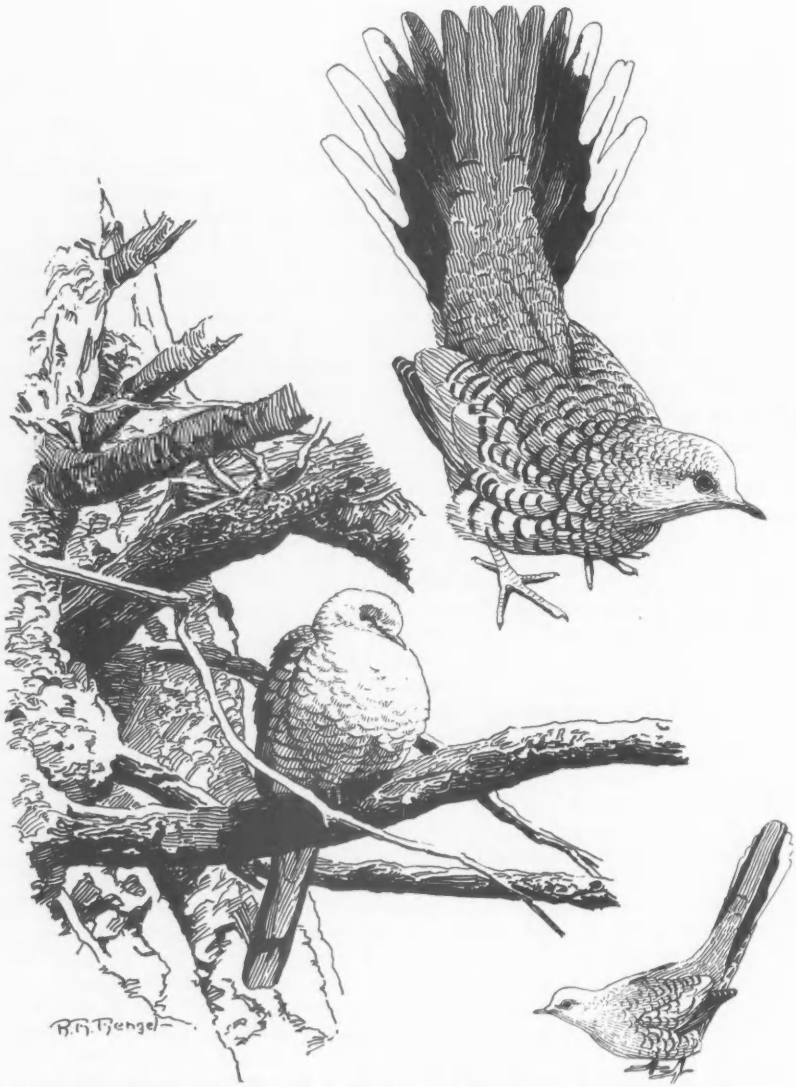

Fig. 2. Upper, courtship fanning of the tail by a male Inca Dove; center, roosting posture of an Inca Dove, from a photograph of a bird loafing in midafternoon in winter; below, aggressive tail fanning by a male Inca Dove.

havioral matrix during the season of breeding; the specific, primary breeding activity is superimposed on them.

It is pertinent here to note that at least *Scardafella, Zenaida asiatica,* and, under certain conditions, *Zenaidura macroura* have a tail-raising habit on alighting. In *Scardafella* about one second after alighting, and in *Zenaida* and *Zenaidura* about two or

three seconds subsequent to alighting, the tail is pumped abruptly up two or three inches. In its present form this movement probably has to do with anxiety. It is important to note that female Inca Doves raise their tails about 1½ inches when they are put under stress—*this is a signal of anxiety; however, females do not fan the raised tail.* Agonistic tail raising and fanning may well have been derived from such a signal of unrest. Goodwin (1955:63) suggests the simple pump had its ultimate origin as a balancing movement; the possible derivation of a sign of psychic disquiet from one of physical unbalance certainly merits attention. It is also of interest to note that tail raising after alighting does not occur in *Columba flavirostris, C. livia, C. fasciata,* or *Columbigallina passerina,* and none of these exhibits vertical epigamic or agonistic fanning.

Nest construction.—The building of nests by Inca Doves, as in practically all other columbids, is a cooperative undertaking of members of the pair. Typically, the males gather nesting material and the females sit on nest sites or partly-built nests and arrange material brought by the males. Building by these doves in New Mexico occurs in the morning hours and ordinarily ceases by about 10 a.m. At least three times as much time is spent by males in searching for nesting material as is spent in transferring it to females. In one instance of intense building activity a male averaged 47 seconds on the ground and 13 seconds at the nest site; 12 trips to and from the nest were made in 12.2 minutes. This is as much building activity as an observer is likely to see in Inca Doves in New Mexico; such a schedule is also characteristic of *Columbigallina talpacoti* (Skutch, 1956:190), but it is of course surpassed by the more intense activity seen in some other doves, as, for instance, *Columba livia,* males of which I have observed to make five or six trips per minute for a quarter-hour. Exceptionally, females gather nesting material while males remain at the nest site in an apparent reversal of the usual roles of the sexes. I observed this to happen once; a pair tended to alternate the hunt for material for about a 20-minute period one morning. The alternation was not complete, however, and the female made about one-third of the total trips. Also, the male did not arrange nesting material at the site.

Building usually occurs on about three consecutive days. Frequently nests are partly made and then deserted or ignored. A pair can build one or two "false" nests before the final nest is made. False nests do not persist long; winds or House Sparrows (*Passer domesticus*) remove the sticks. False nests seem to have no function of themselves; it would seem that the doves engage in the building activity for its own sake, as if it were a necessary part of the rituals leading to the laying of eggs.

Building routines follow this pattern: males fly to the ground and look for sticks and other pieces of vegetation, and many are examined; when suitable pieces (possibly determined by weight, Lorenz, 1955) are found, males fly with them, one piece at a time, toward the positions of females and alight nearby, walk to the females, and climb on their backs. When the males are on the mid-scapular region of the females they pass the nesting material to or toward the sides of the females, who place or arrange it in the nests. This sequence seems to be necessary as a sequence, and it amounts to a rigid ritual. Even the routes to the females tend to be the same each trip.

This ritual is doubtless an important part of the epigamic activities of Inca Doves. Possibly it is pre-copulatory in nature, but copulation begins well before nest construction is begun, although it continues through the time of nest building and probably while the clutch is being laid. Lehrman (1955:249) has shown that stimulation by the heads of young of the outside of the crop of parental Ring Doves (*Streptopelia risoria*) plays an integral role in bringing about the complex of behavior called regurgitation feeding; by analogy, it is possible that peripheral stimulation of the dorsum of female

Inca Doves plays a part in stimulation or maintaining a tendency toward copulatory behavior.

While engaged in building, Inca Doves show a marked single-mindedness; they are nearly oblivious to activities around them. The major exception to this is intrusion of another Inca Dove into the territory of the builder. Humans can approach exceedingly close to the doves without seeming to startle or alarm them; such behavior is not wholly typical of the birds at other times of the year.

Nest sites.—Nests on the campus of New Mexico State University were located in medium- to large-sized trees, never in shrubs or on the ground. In 1957, exotic conifers contained four nests and deciduous, broad-leaved trees contained five. Heights of nests above the ground varied from eight to 20 feet and averaged about 16 feet. No *Opuntia* was used as a nest site; Anderson and Anderson (1948:152) reported *Opuntia spinosior* to be a favored nest-site plant in the vicinity of Tucson. *Opuntia spinosior* is present in abundance in the university botanic garden, which is an area suitable for nesting Inca Doves.

Nests were much harder to find along the Río Cuchujaqui, and no generalization can be made from the data gathered. It is likely, however, that the behavior of doves there is similar to that of doves in New Mexico. One nest was located 25 feet up in a tall, deciduous, leguminous tree, and another was at the same height in a bald cypress. At this locality the Ground Dove (*Columbigallina passerina*) is abundant, and it nests low (average of four nests was six feet) to the ground; possibly there is a competition for nest sites between these two small doves, with the result that Inca Doves take higher nesting sites than they ordinarily do. I do not think this a likely thing, but it needs further investigation.

Persistence of nests.—Inca Doves tend to use nests for two or more consecutive nestings. This is significant as far as stability of the nest is concerned. When first constructed an Inca Dove nest is a relatively loose platform of small sticks having a shallow, although definite, cup. During the period of brooding, the nest becomes rimmed and infiltrated with feces and excrement. If the first brood fledges, enough waste will have accumulated to serve as a strong binder for the sticks and grasses of the original nest; a rigid, substantial structure with a fairly deep, broad cup results from this process. A small amount of lining is added before the second clutch is completed, and the second brood, and any subsequent brood, continues to add cement to the nest. Many nests last through the fall and winter in good condition and are available for use the following year. I was not certain that any pair I watched used a nest from a previous year, but pairs commonly seemed to do so in the Tucson area (Anderson and Anderson, 1948: 152). There, one nest was actually used for four successive years, housing 11 broods.

Spring windstorms frequently blow down first-effort nests of Inca Doves, but the short, violent storms of summer rarely damage the aged, cemented nests. The likelihood of young being fledged increases considerably if the nest has been used successfully at least once before. Such a situation reduces egg and nestling mortality as the season progresses. Mortality rates of eggs and nestlings of Inca Doves should thus be continually shifting in value in time, posing an interesting problem for further work.

Aberrant nestings of Inca Doves exceptionally may be damaged by the increase in weight of feces. One such nesting occurred at the house of Dr. A. R. Phillips in Tucson. The doves placed the nest on a wooden lattice and the cup was directly over an opening of some 2-inch by 2-inch squares in the lattice. The first brood fledged successfully, but continued use and possibly the added weight of the cement eventually worked the nest through the opening and the second clutch of eggs was destroyed when it fell down (Phillips, MS).

TERRITORIALITY

Territoriality in Inca Doves qualitatively resembles "classical" territoriality seen in passerine birds. A pair of doves during the season of major breeding is oriented toward a specific plot of ground in which mating, foraging, nesting, and parental activities take place; this plot of ground has more or less clearly defined boundaries that are known by the occupant pair and the neighboring pairs of Inca Doves; this plot of ground is defended against intrusion by any other Inca Dove. This is wholly true in Sonora, Arizona and New Mexico, but only partly true of breeding activity in winter in southern Texas, and presumably also slightly farther south.

It is important to note that the Inca Dove as a species actually breeds all the year around in the more nearly tropical parts of its range; this is emphasized by Dickey and van Rossem (1938:196) for El Salvador. In southern Texas (Sinton; San Benito, Cameron County) a few pairs of Inca Doves can be found nesting and holding "territory" in winter; young are known to have fledged in December and January. The relationships of these breeding males to their domiciles (sites of breeding activities) and to nonbreeding doves are not quantitatively typical of territorial behavior in spring and summer. At Sinton in the first two weeks of December, 1958, there were at least two pairs of Inca Doves with nests. These pairs were surrounded and their "territories" constantly infiltrated by flocking, nonbreeding doves. Aggressive, territorial defense occurred infrequently; in fact, all that I saw was intentionally provoked by me with imitated calls, and the "defense" postures and vocalizations were directed at me, not at other Inca Doves. "Driving" occurred only once in the six days that I watched the birds. Intruding birds were treated much as are juveniles during the main season of breeding: they were ignored. The significance of some of these matters will be treated where appropriate beyond.

Territories of Inca Doves vary in size and shape, presumably in relationship to the spatial configurations of important elements in the immediate environment. Certain doves tend to behave spatially in an unpredictable manner, and operation of other, possibly psychological, factors is evident. In Sonora the territories of these birds were strung out linearly along the Río Cuchujaqui. These territories were narrow and ordinarily were placed on one side of the stream bed and flood plain; they were 30 to 50 yards deep and 70 to 100 yards long. In the Mesilla Valley, territories were slightly smaller and were oriented primarily with respect to the vegetation available; they were not in a linear arrangement. Sizes ran from 30×50 yards to 70×70 yards.

Nests were sometimes placed near the peripheries of territories. Once two nests were only 30 yards apart; it is notable that the adult birds did not engage in territorial conflict any more frequently than average because of this arrangement. In fact, nest sites do not seem to be an important part of what Inca Doves apparently require in a suitable territory, beyond the fact that some kind of site must exist. The primary requisites are two: clear area, on which the doves forage, and some kind of tall vegetation, where the birds take cover, court, roost, and nest. Thus it is that the typical Inca Dove breeding territory is frequently found in man-made situations, as in urban parkland, or in the arid southwest, along streams where natural vegetation has been partly removed.

Examples of typical territorial behavior can be seen a few weeks after the beginning of epigamic displays. It is not possible exactly to describe incipience of territoriality in a population, because individual birds vary widely in expressing such tendencies early in the season. Males or pairs having nests and eggs have been seen to tolerate territorial trespass early in the season, and later they have been seen vigorously to repulse intrusion. Generally, territorial behavior occurs in low intensity two or three weeks after early courtship behavior is evident, or from one to three weeks before eggs are laid.

Driving of females by males sometimes was seen about the time of beginning of courtship displays, and occasionally this is the first form of territorial behavior to be seen. It is nevertheless possible for driving to occur without reference to an established territory, and the early occurrence of driving may not technically qualify as territoriality, in spite of probably identical neural motor paths.

Vocalizations.—A call that can be related to maintenance of a pair of birds on a specific plot of ground will be territorial in nature. In Inca Doves three calls are given that fall into this category; the first is the courtship call, the second is the "song," and the third is the aggression call. The first already has been discussed; its role in the establishment and maintenance of the pair bond is a relatively simple one and needs no further comment.

The "song" of the Inca Dove is a soft, repeated *coo-coo*. That this is song in the sense commonly associated with passerine song, and is indeed basically aggressive during the season of breeding, can be tested at practically any time in spring and summer. A simple human imitation of the call will cause males from two or three nearby territories to respond in like manner. If the human persists in calling, one or more of the doves will come close to the source, and after that time the birds will continue for some time calling by themselves, sitting near the peripheries of their territories, but not ordinarily leaving them. Males breeding in winter in southern Texas also respond in this fashion if the calls are given near the nest; otherwise calling is largely ignored. Intruding birds in winter are, for that matter, also ignored, and little territorial calling is evident in such situations. Reasons for such a turnabout in response in winter are not clear. It is, however, probably significant that flocking birds rarely call and such calls are not prolonged.

If one Inca Dove intrudes into another's territory, the "song" increases in frequency and is superseded by the aggression call. This call has been briefly described previously (p. 9); it is of throaty quality, with the last three syllables accented so that they can be heard by an observer 50 to 75 yards distant. Frequently the call becomes almost continuous, as *cut-cut-cut-ca-dóah-cut-cut-cut-ca-dóah-cut-cut,* from excited males. Each call is accompanied by an incomplete raising and fanning of the tail (fig. 2), and each series by a series of tail movements. This stage is as far as a male is likely to go if he is a winter-breeding bird; behavior of the intruder is probably important in releasing more intent aggression. Continued trespass in summer is inevitably followed by chasing, which resembles a supplanting attack, or by actual contact between two birds.

Horizontal display.—This display results from continued trespass and it is given by the resident bird; it leads to the culmination of a series of activities that eventually remove an intruding bird from a territory. The occupant male orients himself parallel to the surface on which he is standing. Approach toward the intruder follows; some approaches are direct, but most of them involve small detours along the way, so that a rough zigzag is described by the bird. Aggression calls are now almost continually given, mainly by the occupant. After ten seconds to five minutes of such display the occupant frequently goes into the wing-up and unilateral rush.

Wing-up and unilateral rush.—In most instances when the occupant male is within six to 15 inches of the intruder, the occupant rushes obliquely at the intruder, with the distal wing raised. Contact may not be made following a unilateral rush, but if the intruder does not leave, the two birds always make contact, beating vigorously with wings and pecking with bills in the usual columbid manner; they rise perhaps a foot in the air on these occasions. I have yet to see an intruder best an occupant in such combat. Likewise I have never seen the "bloody" combat between these doves that Gilman (1911) has described.

The raised wing probably indicates the readiness of Inca Doves to hit with the wing;

such wing-up displays are signs of aggressiveness in most pigeons and doves. In Inca Doves the wing-up is also used in nonterritorial situations that call for aggressive behavior, as when a male mounts another male in the early part of the breeding season. Mounted males will crouch down and push up one wing; this tends to dislodge the upper bird and also is an aggressive action tending to discourage further errors of perception. The wing-up is also used in interspecific strife (see beyond).

Probably the observations of Evenden (1954:53) on Inca Doves "courting" in Zacatecas fall into the category of aggression. Evenden reported a presumed male circling a presumed female, "dipping its head, spreading its tail, and extending its wings on [*sic*] a 'V' over the body, thus showing the chestnut of its wings . . ." Extension of one or both wings is something I have never seen in epigamic situations, and I cannot agree that Evenden's observations dealt with courtship; some aspect of aggression was probably involved. Also, the chestnut of the primaries and secondaries has never appeared to be important in epigamic display of Inca Doves I have seen. It is possibly important in *Columbigallina passerina,* males of which in courtship vibrate and flash the wing partly open and reveal chestnut color otherwise hidden.

Driving.—Driving is a type of herding of the female by the male. The usual form of driving is one in which the male appears to attempt to occupy the spot the female is on; invariably the female moves a short distance away. When the female moves one to six feet, the male follows, and three or four to a dozen such moves may be made before the male ceases to "push" the female onward. Late in the breeding season, after some pairs have ceased to breed, driving sometimes takes a more relaxed form, in which the male merely herds the female in a certain direction, by placing himself between an intruder and the female and continuously walking. No direct flights are involved in this latter behavior.

In other columbids (Goodwin, 1956:33) it seems that a mated male "drives" when another male is near the former's mate. This is true in the Inca Dove. Driving always occurs if a male encroaches either on a pair sitting or foraging together or on a temporarily unaccompanied female; driving is in fact the only expression of aggression by the territorial male under these circumstances. Straightforward aggression against the intruder sometimes follows an instance of driving, but territorial aggression may actually be terminated by the territory holder in order to drive his mate from the arena. It is thus seen that driving is a form of aggression directly related to maintaining the mated pair and is in part a direct response of a male to an intruding male. It is also in part directly related to the nearness of the female to the intruder.

Goodwin (*loc. cit.*) believes that the immediate objective of driving is removal of the female from possible sexual rivals of her mate. This hypothesis is not wholly unlikely, but it implies reasoning ability on the part of the territorial male and has additionally an overtone of anthropomorphism. Since driving is strongly stereotyped behavior, it is unlikely that reasoning or learning would play a major part in its release. Unfortunately, no alternative hypothesis concerning causation and ultimate function of driving seems much more attractive. Robert I. Smith has suggested to me that driving may be a form of redirected aggression in which the male, frustrated in outright aggression against other males, "turns back" aggressive drives onto the female; this phenomenon is relatively common in vertebrates. However, redirection occurs in no behavior I have witnessed in Inca Doves and it is unlikely to occur as a ritualization in driving.

Discussion.—Territorial behavior in Inca Doves results in the pairs being spaced through the suitable habitat available to a population. It is tempting to say that spacing is a function of territoriality in Inca Doves. Spacing seemingly "ensures" an adequate arena for effective nesting and rearing of young. All the behavior of a breeding pair

tends to be meaningful only with reference to a restricted area of suitable habitat and the aggressive elements of behavior tend to isolate the pair from other pairs. Spacing and those elements associated with spacing thus seem to be adaptive.

It must be mentioned briefly that the relationships evident in winter breeding in southern Texas do not support such a conclusion nor any heretofore reasonably acceptable hypothesis concerning the possible functions of territoriality. It is perhaps best to ignore winter breeding of this type, especially in view of the fact that such breeding is probably of little significance to the population involved. The birds breeding in winter in Texas probably are similar to doves in tropical American where breeding on a year-round schedule is not only possible but presumably adaptive. Certainly those features characteristic of "normal" territoriality in Inca Doves at higher latitudes could never have developed if there were selective advantage to the nonexclusive nature of "territoriality" seen in winter in southern Texas.

Several elements in aggressive, territorial behavior will be recognized as appearing in courtship behavior described earlier. Specifically, there is a strong relationship between the aggression call and the courtship call, between epigamic and agonistic tail fanning, and between heteropreening and aggressive pecking. It some cases the agreement in general pattern of behavior is remarkably good, and there is no reason to believe the relationships are other than real.

When such a relationship is postulated, it is useful further to inquire concerning derivation of the elements. Aggressive behavior is almost certainly more primitive in a species than are the contemporary epigamic patterns; note, for example, that Inca Doves and Rock Doves, which are not particularly closely related, share certain aggressive behavior patterns such as driving, hitting with the wing, raising the wing as a signal of intent to hit, and biting and stabbing with the bill. But they share no single epigamic behavior. It is thus reasonable to suppose that present courtship patterns have been derived from earlier, more generalized aggressive patterns.

Many ethologists (see Moynihan, 1955, and Tinbergen, 1958, for reviews) have taken the position that ritual displays have as their origins certain simple behavioral precursors; these can be classified broadly as "intention" movements, "redirection" activities, and "displacement" activities. From this point of view the elements of epigamic display discussed here would have to be classified as ritualized "intention" movements of attack or escape. It seems unlikely, as mentioned earlier, that "redirection" occurs obviously in Inca Doves, and thus far no ritualized "displacement" activity has been detected. It is possibly a matter of terminology at present whether epigamic displays of these doves should be considered as derived from the actual attack and retreat elements of general aggressive behavior, or whether they can be considered as derived from movements of intention of attacking or fleeing. The latter terminology is perhaps preferable since in these birds aggression is most often expressed as threat, that is, as *intent* to perform in a hostile manner. I doubt that the ethologists consider the matter merely as one of terminology, as is here suggested. It is instructive, however, that there is some agreement that "intention" movements comprise the great bulk of sources for ritual display; relatively few "redirection" or "displacement" sources seem to have been found in any animal species, and some of these are open to different interpretations. Certainly the latter sources seem not to be important in Inca Doves.

Certainly also the behavior of a displaying bird occurs with reference to another bird and with reference to the actions of the other bird in a precise behavioral gestalt. For instance, male Inca Doves initially tend to behave in but one way to another dove in the spring: they exhibit a generalized, low-level aggression (vocal challenge, head bob, heteropreening, charge with mounting). What happens subsequently is dependent

on the response of the second bird; if it is a male, further aggression takes place (is "suitable"), and the relationship between the two birds is transitory; if it is a female, a relationship tends to be formed (in the absence of a previous one), and behavior cannot longer be aggressive to effect this. Hence, modifications in general aggressive behavior have developed from the material immediately at hand, namely the agonistic patterns.

It is worth emphasizing differences in quality of responses of birds approached by an aggressive male; the present hypothesis deriving epigamic from agonistic behavior patterns is greatly dependent on this. A sexually-based dichotomy of behavioral response is of course evident in breeding populations, but it is perhaps more clear in the behavior of birds flocking in the territories of breeding pairs in winter. The lack of response by adults and juveniles to the territorial male effectively concludes any challenge; if an adult female is challenged and she tends to behave sexually, and this is a strongly positive response in contrast to no response at all, a pair tends to be formed or maintained. Winter breeding conditions clearly emphasize the foundation of behavioral response on hormonal condition. It is perhaps superfluous to mention that gonadal and hypophysial hormones strongly determine vertebrate sexual behavior and that at temperate latitudes hormonal levels tend to vary seasonally (for example, see Beach, 1958:89).

INCUBATION AND BROODING

The period of incubation in Inca Doves is 13 to 14 days, at least in Arizona (Anderson and Anderson, 1948:152) and in New Mexico. The birds tend to cover the eggs nearly every minute of the day, and the routine at the nest is the normal one for pigeons; males tend to sit in the middle of the day and females to sit from late afternoon to the following midmorning. The birds are for the most part unobtrusive while sitting but occasionally they give the territorial, *coo-coo,* call. Possibly both males and females give this call when incubating, although otherwise females rarely call in the breeding season. I was never able to determine the cause of such calling. It certainly is not a "nest call" in the strict sense of the term, as this ordinarily applies to a distinct note or notes used in no other context. Skutch (1956:194–195) believed that similar use of a nonspecific nest call (the regular *coo*) in *Columbigallina talpacoti* was a signal that the sitting bird wanted to be relieved by its mate. This interpretation was never suggested to me by activities of Inca Doves.

They never give distraction displays when leaving the nest precipitously. The birds are exceedingly "tight" sitters and do not flush from nests until so late that any seeming value of distraction display would be mitigated. The related species of *Columbigallina* (*passerina,* in Sonora, and *talpacoti,* Skutch, 1956:196) occasionally exhibit distraction display in fairly typical fashion, simulating wing injuries, as do Mourning Doves and White-winged Doves. Inca Doves are not, in areas where I studied them, ground-nesting birds; since there is a positive correlation between ground nesting and distraction display it is reasonable that Inca Doves do not so display.

Brooding occurs for seven to nine days, and the young leave the nest 14 to 16 days after hatching. Following this time the young are attended by the parents for perhaps another week, during which time the young become progressively more independent of parental care. Resumption of nesting activities ordinarily occurs in short order; juveniles leave the parental territory and eventually take up group activities on foraging and loafing grounds with other juveniles.

Renesting.—In New Mexico many Inca Doves nest four times in one year, and some pairs probably nest five times. I have records of only six pairs nesting in 1957. Of these, three pairs nested at least twice, one pair at least three times, one pair at least four

times, and one pair probably five times. These were not all successful attempts, but the two instances of at least four attempts each saw three successful nestings in succession, followed by an unsuccessful terminal attempt. These two pairs each used one nest apiece for the entire season, emphasizing the earlier remarks concerning success of reproduction in reinforced nests. In one of the foregoing series of nestings, the second clutch was deposited on April 24, the third on May 25, and the fourth in late June or early July; in the other series, the second clutch was deposited on May 24, the third (or probably fourth) on July 27, and the fourth (probably fifth) in late August or early September. In each series the first nesting attempt by the pair occurred before I found the nests, which were aged and cemented when I found them. The earliest nest with eggs was found on March 15, in 1957; ample time was available for the presumed first nesting. In the second series outlined above I missed recording a nesting for late June, due to my absence at that time; it probably occurred and probably was successful.

INTERSPECIFIC RELATIONSHIPS

Conflicts with five other species of birds are the only items to be noted in this category. Inca Doves tend to take a passive role in the face of aggression only in winter. In the breeding season these doves are notably aggressive, and few other species act aggressively toward them.

I once saw an Inca Dove chase another from its territory, without much of a battle; the territory holder, still displaying and calling vigorously, then flew directly at a Ground Dove and forced it to take wing and leave the immediate area. It is likely that the Inca Dove misidentified the Ground Dove as one of its own species, for the Ground Dove resettled in the Inca Dove's territory after flushing, and the latter did not pursue the Ground Dove further. If misidentification is ruled out, this event could be classified as interspecific, redirected aggression.

A Black Phoebe (*Sayornis nigricans*) once foraged low over an area in which a pair of Inca Doves were working for seeds. The phoebe at one point made directly for one of the doves; the latter held up one of its wings and the phoebe veered off sharply and left the foraging ground. Perhaps the phoebe through previous conditioning had interpreted the raised wing as a signal of aggression; phoebes, however, never use their wings in this manner.

In winter, Mourning Doves, Boat-tailed Grackles (*Cassidix mexicanus*), and House Sparrows sometimes make Inca Doves remove or retreat by means of aggressive action. A short, horizontal rush is enough by each of these species to make Inca Doves move. On two occasions, however, an Inca Dove managed to best a House Sparrow in a minor squabble; each time the dove merely held up one wing and looked at the sparrow. This occurred on a foraging ground, and in neither instance was the sparrow hostile at any time toward the dove.

Boat-tailed Grackles frequently make doves move. On one notable occasion a first-year male grackle seemed purposefully aggressive, or actually predatory, toward Inca Doves. This bird strode vigorously around a barnyard foraging area, making short dashes at doves and appearing to peck them; it went so far as to pursue one dove in flight for a short distance. Twice the grackle peered intently at a dove, seeming to attempt to make certain of the dove's identity, before striking out at it. The grackle ignored House Sparrows and Brewer Blackbirds (*Euphagus cyanocephalus*) that also were foraging in numbers nearby.

AUTUMNAL SEXUALITY

In September and early October in New Mexico, Inca Doves are quiet; this period sees the height of the molt and its termination. In late October and early November

the birds again give the *coo-coo* call, associated in the spring and summer with incipient breeding behavior and territoriality; the sizes of testes of adults in October are midway between those of breeding condition and total regression. Two individuals were seen to bob in early November, and one bird fanned its tail in December. Nevertheless, no spacing of individuals was effected by these activities; "autumnal territoriality" of various authors (Nice, 1937; Johnston, 1956) as recorded for passerine birds seems of a different nature. In Inca Doves there might be gonadal recrudescence, but mostly this is reflected in abortive courtship activity rather than in the kind of aggression between males that brings about a territorial situation. It is likely that breeding behavior does not cease in populations where winter breeding occurs, but the cycle of activity of individuals is unknown. Specimens from southern Texas show no indication that timing of molt is other than that normal for populations in New Mexico.

GROUP BEHAVIOR

It is rare for an Inca Dove to do anything alone, and in the broad sense all behavior of these birds is social. The present section of this report deals with nonbreeding behavior and the emphasis is on that sociality evident in groups of Inca Doves; nearly all activity carried on outside the breeding season occurs in groups. The birds thus operate in groups (nonbreeding) under one hormonal regime and not in groups (breeding) under another. This amounts to a truism, but it must be emphasized if sense is to be made of the strikingly different modes of life evident within the two periods. The primary characteristic of group life in Inca Doves is the almost total lack of aggression on the parts of all birds. Lack of aggressive tendencies is almost without question due to the hormonal balance in males, chiefly. Stimuli evoking aggressive responses in the breeding season are frequently completely ignored by birds in groups.

FLOCKING

Where there are large foraging areas, such as livestock pens, barnyards, zoological gardens, or waste dumps near grain warehouses, fledged juveniles and nonbreeding members of populations of Inca Doves tend to gather into large, loose flocks. Most individuals in flocks in late summer and early autumn are juveniles. All breeding individuals remain territorial of course, and these birds join the flocks late in the year unless they continue breeding throughout the winter. The flocks persist until about February, when more and more birds leave to take up breeding activities.

Where there are no large foraging areas, as in the small cities of southern Texas and México, the flocks are small, and instead of consisting of 100 or more doves they may be made up of perhaps a dozen birds. The behavior of birds in the large and the small flocks tends to be remarkably similar. The cause of this lies probably in the fact that within large flocks smaller groups of 10 to 40 birds tend to maintain themselves as units, and these form nearly autochthonous foraging and loafing flocks.

The daily activity of these groups is notably uniform and notably restricted to relatively few kinds of behavior. A typical flock of ten or 20 birds will begin foraging in midmorning; the birds leave their nightime roosting sites earlier on warm and sunny days and later on cold and overcast days. Thus, in New Mexico the doves most frequently begin to forage at about 9:30 a.m. in midwinter, but in southern Texas they start an hour or more earlier. The flock forages for perhaps an hour and then moves for perhaps another hour to sunning and loafing sites. Following this the birds forage again and then loaf, and this routine is repeated until the birds go to roost. In New Mexico in midwinter the doves move to roosting sites at about 4:00 p.m. and in Texas about a half-hour later.

In tropical areas a large proportion of doves in a population is engaged in breeding throughout the year. In such populations the majority of the birds in groups would be juveniles. There is no indication presently available as to whether the behavior of such groups differs either in general daily activities or in specific features of organization.

Sunning.—A great deal of the daily activity of Inca Doves consists of resting or loafing as has been already indicated. The most striking thing done by members of resting groups is sunning. A few to several birds, ordinarily sitting symmetrically, roll partly over on one side and slightly raise the upper wing, which is partly fanned at the carpal joint, and erect all feathers on the side toward the sun. The eye is kept open, but I cannot say that the birds stare at the sun. After ten seconds to two minutes of this the birds sit upright again and then preen body and flight feathers, occasionally working with the bill at the uropygial gland. The process of sunning and preening may be repeated two to four times in short order. Prolonged sunning (Hauser, 1957) does not seem to occur. In summer, Inca Doves do not have an obligatory behavior toward the sun, as Hauser has reported for the Mourning Dove, but not for the Ground Dove; I saw but one Inca Dove assume sunning posture in three summers of observation.

Resting, with sunning behavior, almost always occurs in strong sun, and in New Mexico on a wooden or concrete substratum or on a south-facing earthen mound, or against a wall of some type; in Texas such activity is not necessarily associated with such "sun-traps," and the birds ordinarily rest and sun on flat ground or in trees. Such variation in sunning behavior probably is a function of relative incidence of cold weather and strongly suggests that conservation of energy is the primary objective of such behavior.

Roosting.—Inca Doves roost in evergreen trees. In New Mexico these are almost exclusively exotic conifers but farther south native, broad-leafed evergreens are most frequently used. Birds leave foraging and resting areas in loose groups; the several members of a group leave in pairs or singly, rarely in trios, and the group recongregates within one or more trees. On any one perch the birds associate in units of two or more; I have never seen a single bird roosting.

The doves usually go to roost about one-half hour before the sun sets but occasionally make their way to roosts in mid-dusk. Groups frequently leave for the roosting sites one or two hours before sunset in midwinter. Under the latter circumstances the birds go through a period of intermittent shifting of positions and quiet perching; some individuals actually assume the sleeping posture and close their eyes (fig. 2). Eventually the birds become quiet as a group and spend the rest of the night wing-to-wing; occasionally one or two birds roost on the backs of other individuals. "Social roosting" of this type also occurs in *Geopelia* (Whitman, 1919), *Columbigallina passerina,* and *C. talpacoti* (Skutch, 1956:88).

Pertinent here is the fact that recently-fledged Inca Doves are attended by their parents for, ordinarily, about one week's time. In this period a family unity is maintained and the adults are accompanied by the young when roosting. The three or four birds of any one such group make their way to roosts about dusk, and the individuals typically sit wing-to-wing.

MAINTENANCE OF UNITY OF THE GROUP

It is striking that few evidences of any mechanism for maintaining groups are apparent in these doves. It is important, and probably no accident, that almost no aggression is seen in groups. It is not that aggression is out of place in groups (many other birds show aggression in groups), but in Inca Doves the only kind of aggression ever seen tends to separate individuals and thus might break up the groups. Individ-

uals in fact associate closely with one another; the concept of "individual distance" has no validity in Inca Doves. Birds frequently touch each other when resting or sunning, as well as when they roost. Additionally, in wild flocks, there is no "peck order" or any tendency for a leader to develop in any activities undertaken in flocks. Yet, to emphasize the lack of aggression in these flocks is not to explain how the groups are maintained nor how they function as units.

It is likely that at least one way in which the groups are unified is by vocalizations. However, this is by no means so clear cut as it is in other kinds of birds in groups. Infrequently—once every 10 to 30 minutes—a brief round of calling, *coo-coo*, occurs in the flock of Inca Doves. The notes are given almost offhand, one or two calls from perhaps three or four birds in a group of 10 or 15. The calling schedule is a flexible one, as I have indicated; yet, it is not possible to arouse calling from a group that has just finished calling. Ordinarily a human imitation of the call will arouse a round of calling only if perhaps 20 minutes has elapsed since the last previous round, although infrequently they can be aroused after an elapsed time of 10 or 15 minutes. The rounds of natural calling, in spite of their temporal flexibility, probably serve to orient individuals to the position of the bulk of the group.

The sound made by wings in flight perhaps also helps orient birds in groups. Movement of the group aerially simply cannot occur quietly and it is not reasonable to assume the doves are unaware of the wing sounds.

Finally, vision doubtless plays a large role in group orientation, but this is hardly susceptible even to experimental proof; a dove without sight would behave aberrantly in almost every way. It is clear that Inca Doves seek out other doves by sight in epigamic and agonistic activity, and they probably do so when in groups.

Thus in Inca Doves there is practically no evidence of strong regulation of group interaction. There is no social hierarchy (seeming lack of dominance-subordinance relationships), there is no "individual distance" or "social territoriality," there is no leadership-followership behavior, with fixed roles held by individual birds. There is only a weakly-expressed group bond, manifested not by display or strong rituals but by extremely simple auditory signals, in spite of the fact that the birds are in winter markedly group-oriented.

SUMMARY

Behavior of the Inca Dove (*Scardafella inca*) was observed from 1956 to 1958 in southern New Mexico, Texas, and Sonora. Functional epigamic display occurs from February to September, but most frequently in March and April, when the pair bond is being formed. Displays of low intensity are followed by a display featuring the vertically-fanned tails of males; this ritual seems to be a powerful stimulus in bringing about primary sexual activity of both sexes, especially that of females. Nest building is a cooperative undertaking of the sexes; stages in the building process are strongly ritualized. Feces and excrement of young infiltrate and strengthen nests; subsequent use of these probably lessens egg and nestling mortality, for the strengthened nests resist destructive elements of the environment.

Inca Doves are markedly territorial; this is strikingly manifest in vocal behavior and in certain ritual displays, including tail fanning, wing raising, fighting, and driving of females by males. Spacing of pairs of doves through suitable habitat seems to be a function of territoriality.

The similarity of certain epigamic and agonistic patterns of behavior suggests that the former have been derived from the latter.

Group behavior in winter is strongly marked in foraging, resting, sunning, and roosting. Behavior of birds in winter in response to aggression of a few birds that still are

breeding indicates that the response of a bird that is challenged is as important in determining subsequent behavior as the kind of challenge received. Both actions are largely dependent on the hormonal condition of the indviduals involved. There seem to be no marked mechanisms for maintenance of the group; simple auditory signals seem to be important.

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HYBRIDIZATION IN THE ANATIDAE AND ITS TAXONOMIC IMPLICATIONS

By PAUL A. JOHNSGARD

Without doubt, waterfowl of the family Anatidae have provided the greatest number and variety of bird hybrids originating from both natural and captive conditions. The recent compilation by Gray (1958) has listed approximately 400 interspecies hybrid combinations in this group, which are far more than have occurred in any other single bird family. Such a remarkable propensity for hybridization in this group provides a great many possibilities for studying the genetics of speciation and the genetics of plumage and behavior, and it also provides a valuable tool for judging species relationships. It may generally be said that the more closely two species are related the more readily these species will hybridize and the more likely they are to produce fertile offspring. In waterfowl, chromosomal imcompatibility and sterility factors are thought to be infrequent, a circumstance which would favor the large number of hybrids encountered in this group. In addition to this, however, it can probably be safely concluded that the Anatidae are extremely close-knit in an evolutionary sense, for their behavior, anatomy, and other characteristics all indicate a monophyletic origin. It was for these reasons that Delacour and Mayr (1945), in their revision of the group, sensibly broadened the species, generic, and subfamilial categories, and in so doing greatly clarified natural relationships.

Gray's compilation, although it provides an incomparable source of hybrid records, does not attempt to synthesize these data into any kind of biologically meaningful pattern. For the past several years I have independently been collecting records and information on waterfowl hybrids for the purpose of obtaining additional evidence for species relationships and in order better to understand problems of isolating mechanisms under natural conditions. With the publication of Gray's bibliography, little purpose would be served by presenting my compilation *in toto*, since the two lists are practically identical. However, I believe that condensed graphic summaries, arranged by natural subgroups (tribes) rather than alphabetically as done by Gray, have sufficient value and interest to be presented here.

SUMMARY OF INTRATRIBAL HYBRIDS

Inasmuch as the great majority of anatid hybrids involve species of the same tribe, and because practically all natural hybrids known are of this kind, they will be dealt with first. Closely related sympatric species which will occasionally hybridize in the wild are most important from the standpoint of isolating mechanisms. The frequency of such hybridization and the fertility of the resulting progeny are of particular importance in this connection. For each tribe in which intratribal hybrids have been recorded a graph (figs. 1–6) has been prepared which indicates the known combinations and also provides an indication of the relative frequency of such hybridization and the degree of hybrid fertility when it is known. Except for the Ringed Teal (*"Anas" leucophrys* of Delacour and Mayr, 1945), which is considered here to be congeneric with *Amazonetta brasiliensis* of the Cairinini (see Dersheid, 1938), the species constitution of each tribe is that proposed by Delacour and Mayr. However, the exact sequence of species often differs somewhat to conform with what I believe more closely approximates relationships when expressed in a linear fashion. References concerning nearly all the indicated hybrid combinations can be found in Gray (1958).

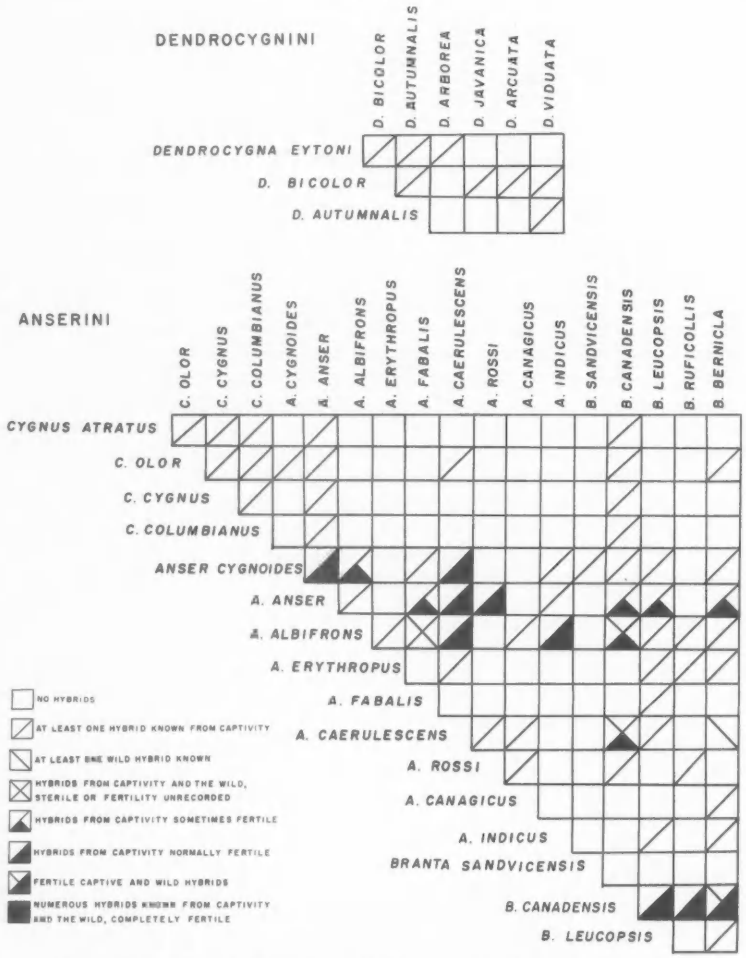

Fig. 1. Above, intratribal hybrid combinations recorded in the Dendrocygnini. Below, intratribal hybrid combinations recorded in the Anserini.

Subfamily Anseranatinae

No hybrids involving the monotypic species of this subfamily, the Magpie Goose (*Anseranas semipalmata*), have been recorded. The species' anatomy deviates markedly from the rest of the group (Miller, 1919), and it is probable that hybridization with other species is genetically impossible.

Subfamily Anserinae

Dendrocygnini.—Evidence from hybrids within the whistling duck group sheds little light on relationships (fig. 1). It is significant however that no intertribal hybrids in-

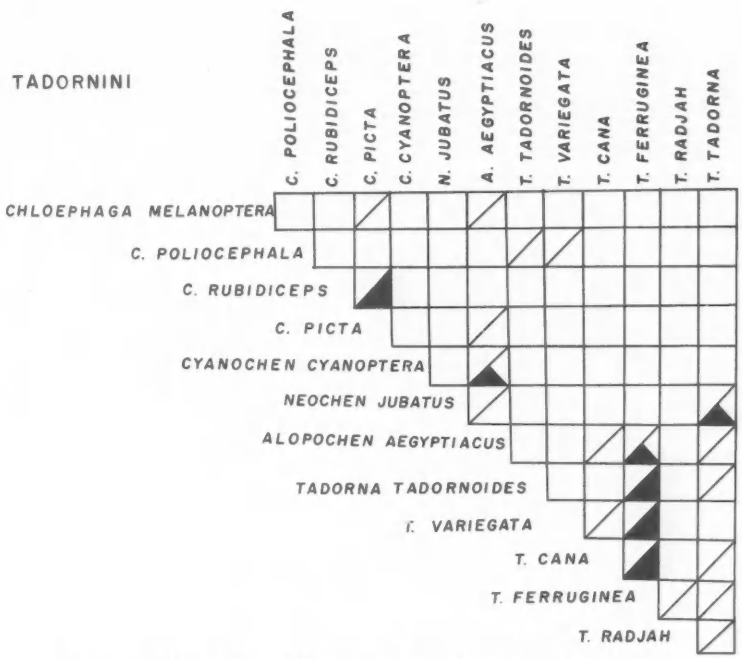

Fig. 2. Intratribal hybrid combinations recorded in the Tadornini. See figure 1 for meaning of symbols.

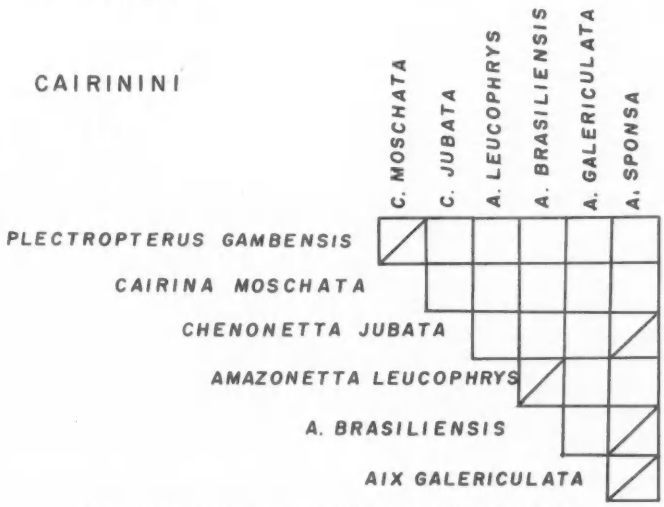

Fig. 3. Intratribal hybrid combinations recorded in the Cairinini.

volving this group are known except for a highly dubious record mentioned by Delacour (1927) for *Dendrocygna viduata* x *Netta peposaca*. This suggests that the tribe is more isolated from the other anatids than are the geese and swans.

Anserini.—The great abundance of swan x goose hybrids known (fig. 1) certainly vindicates the submerging of the previously upheld subfamilies Cygninae and Anserinae,

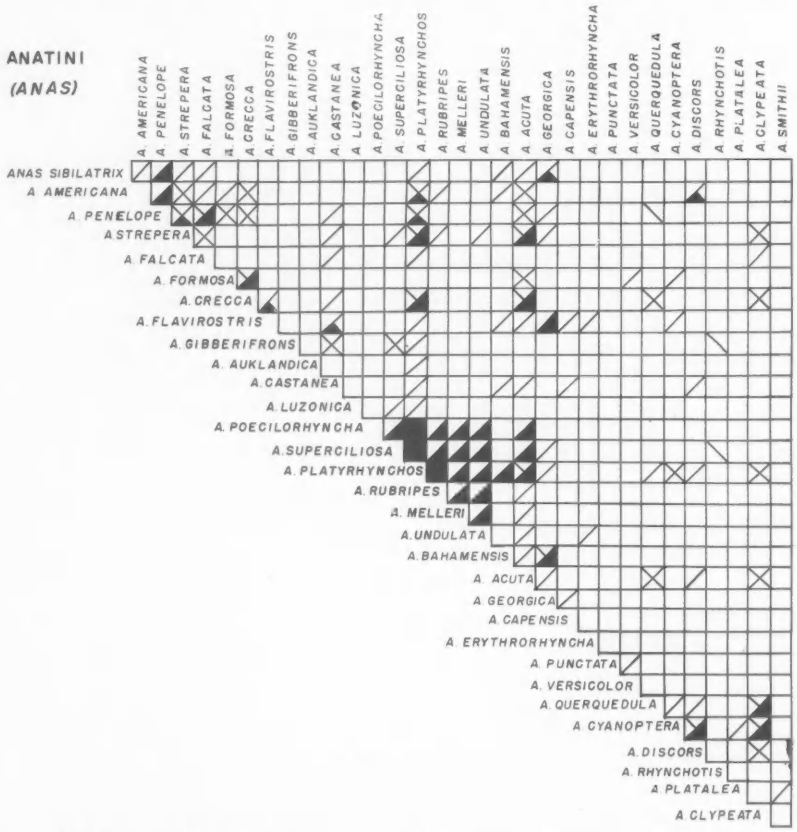

Fig. 4. Intratribal hybrid combinations recorded in the Anatini (genus *Anas* only, see text).

and the numerous goose hybrids also provide justification for discarding several monotypic genera such as *Eulabeia* and *Cygnopsis*. Even with the broad generic concept of Delacour and Mayr (1945), the several fertile intergeneric crosses between *Anser* and *Branta* indicate the very close relationship existing between these two morphologically fairly distinct groups.

Subfamily Anatinae

Tadornini.—Hybridization in captivity involving species of this tribe is relatively prevalent (fig. 2), probably largely as a result of the active part the female takes in

selecting the strongest possible mate, often regardless of its species. Since several of the species are only rarely kept in captivity, the potential list of hybrids has undoubtedly not yet been filled. The fertile intergeneric crosses among *Alopochen, Tadorna, Cyanochen,* and *Neochen* indicate that the number of genera currently accepted is overly large, and possibly some of these monotypic genera are unrealistic.

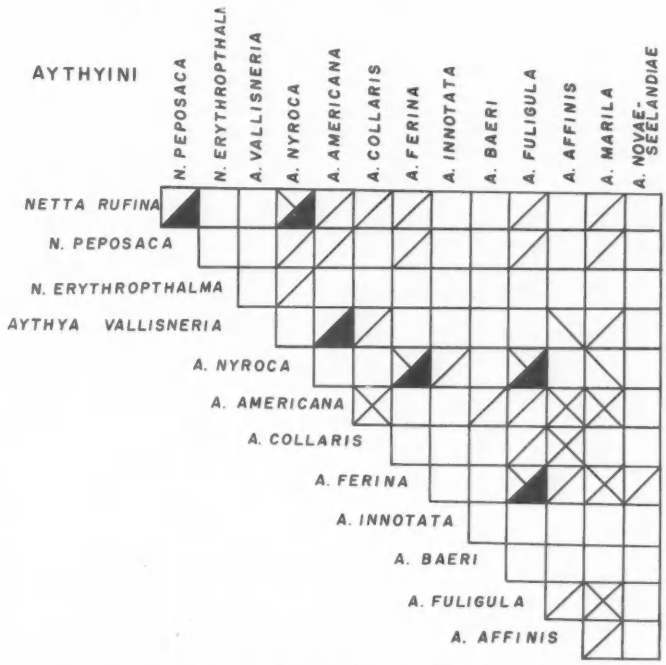

Fig. 5. Intratribal hybrid combinations recorded in the Aythyini.

Cairinini.—The surprising paucity of hybrids within the perching duck group (fig. 3) seems explainable by the possibility that the included species represent a collection of relatively isolated forms which share several rather primitive characteristics and seem to represent the generalized anatine condition from which the other groups have adaptively radiated. None of the intratribal hybrids are known to be fertile, but apparently hybrids between the Muscovy (*Cairina moschata*) and the Mallard (*Anas platyrhynchos*) are rarely fertile. The apparent absence of hybrids of the Wood Duck (*Aix sponsa*) with the Mandarin Duck (*Aix galericulata*) might be explained on the basis of gross chromosomal differences (Yamashina, 1952), but several alleged examples of this cross have been recorded. The Wood Duck has hybridized with a great many species of *Anas*, with some of which the Mandarin has also hybridized, but behavioral (Lorenz, 1951–1953) and serological (Cotter, 1957) evidence indicates that they belong in the present tribe.

Anatini.—A single questionable record (see Gray, 1958) of a hybrid between the New Zealand Blue Duck (*Hymenolaimus malacorhynchus*) and the Gray Duck (*Anas*

superciliosa) is the only one which does not involve only those species considered by Delacour and Mayr (1945) to belong to the genus *Anas*. So many hybrid combinations among species of this genus are known (fig. 4), and such a remarkably high incidence of fertility is present, that one must conclude that the species of dabbling ducks are much more closely related to one another than is often indicated by their external appearance.

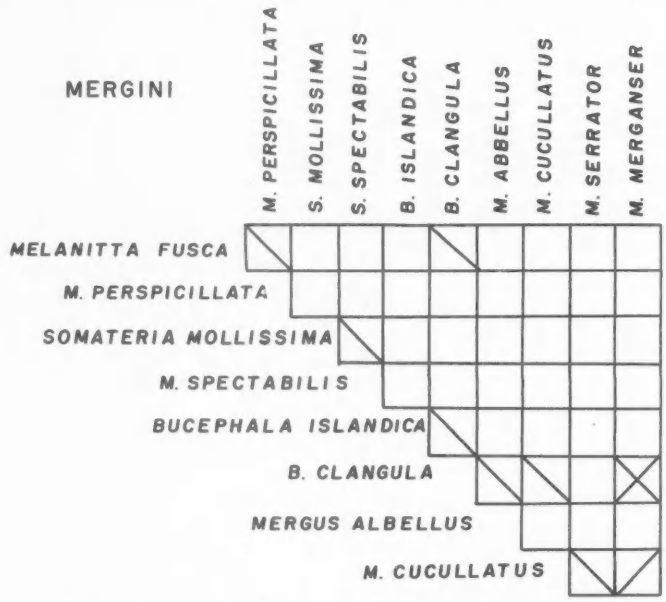

Fig. 6. Intratribal hybrid combinations recorded in the Mergini.

Delacour and Mayr's recommendations of a single, inclusive genus rather than the more than twenty which have been proposed is fully justified on this basis. Fertile hybrids of *Anas* and species of the tribes Tadornini and Aythyini have been occasionally reported, which circumstance illustrates the astonishing capacity for interspecies fertility found in this group.

Aythyini.—The high percentage of the potential hybrids among species of diving ducks that are actually realized (fig. 5) forces one to conclude that the Aythyini represent a very closely related group of species, with two being the maximum number of genera that can be reasonably allowed. Indeed, perhaps the best reason for retaining *Netta* is because it provides such an excellent transitional link between the Anatini and the Aythyini, having provided fertile hybrids with both *Anas* and *Aythya*. The great number of hybrids of *Anas* x *Aythya* (five combinations of which have been found to be fertile) and electrophoretic evidence from egg-white proteins (McCabe and Deutsch, 1952) both argue for a very close relationship between the groups.

Mergini.—The relatively few hybrid records for the sea duck group (fig. 6) very likely reflects their relative infrequence in captive collections, the difficulties of breeding them, and their secondary importance as sporting birds, which reduces the number of

wild-taken hybrids. Except for the remarkable intertribal hybrid between *Anas castanea* and *Clangula hyemalis*, which Delacour (1956) bred at Cleres, and an equally curious hybrid between *Aix galericulata* and *Clangula hyemalis* from Tring (specimen in the American Museum of Natural History), most of the hybrids represent wild-taken specimens. The recent evidence (Humphrey, 1958) that eiders should be placed in a separate tribe near the dabbling ducks might be supported by two alleged crosses of *Anas* x *Somateria*, but behavioral evidence (D. F. McKinney, unpublished MS) argues strongly against this.

Table 1

Intratribal and intertribal hybrid combinations recorded in the Anatidae. Numbers indicate total interspecific hybrid combinations recorded within and among tribes. Reciprocal crosses (such as Mallard x Pintail and Pintail x Mallard) are considered as single combinations.

	Anseranatini	Dendrocygnini	Anserini	Tadornini	Cairinini	Anatini	Aythyini	Mergini	Oxyurini
Anseranatini	....	....	....	....	....	....	....	....	....
Dendrocygnini	....	8	....	....	....	....	....	....	....
Anserini	....	....	65	15	5	3	....	....	....
Tadornini	....	....	15	21	8	5	1	1	....
Cairinini	....	....	5	8	5	28	8	2	....
Anatini	....	....	3	5	28	115	45	7	....
Aythyini	....	....	....	1	8	45	35	6	....
Mergini	....	....	....	1	2	7	6	9	....
Oxyurini	....	....	....	....	....	....	....	....	1

Oxyurini.—Except for a highly questionable record of a hybrid between a Ruddy Duck (*Oxyura jamaicensis*) and a Greater Scaup (*Aythya marila*) mentioned by Sibley (1938), there are no positive records of interspecific hybridization involving any species of the stiff-tailed ducks. Bond (1950) has indicated that intermediate forms between *Oxyura jamaicensis andina* and *O. ferruginea* occur in Colombia, but these probably should be considered subspecific intergrades rather than hybrids (Johnsgard, unpublished MS). One possible hybrid between *ferruginea* and *Oxyura vittata* has also been mentioned (Hellmayr, 1932), but the evidence for this cross is still inadequate.

SUMMARY OF INTERGENERIC AND INTERTRIBAL HYBRIDS

A compilation of records of intergeneric and intertribal hybrids provides a means of estimating the degree of genetic isolation existing among these higher categories. As such it helps to establish a sequence of categories that most closely reflects actual relationships. Thus by totalling the number of known intergeneric hybrid *combinations* (not total *hybrids*), a rough index is obtained to the degree of genetic difference among various genera (fig. 7). Such a compilation clearly indicates the great latitude of hybrid potentiality present in the group (very questionable records are not included), particularly in the subfamily Anatinae. Thus, for example, the Mallard (*Anas platyrhynchos*) has been hybridized with both the Gray-lag Goose (*Anser anser*) and the Common Merganser (*Merganser merganser*), two species which practically encompass the greatest range of morphological variation encountered in the entire family Anatidae.

If a compilation of hybrid records is made at the tribal level (intertribal and intra-

tribal combinations), as has been done in table 1, a further fact becomes clear. This is that the tribe Cairinini belongs between the Tadornini and the Anatini, rather than between the Aythyini and the Mergini, as originally suggested by Delacour and Mayr (1945). In addition, the table illustrates the fact that the whistling ducks (Dendrocygnini) are a distinctly isolated group, whereas the geese and swans (Anserini) are not

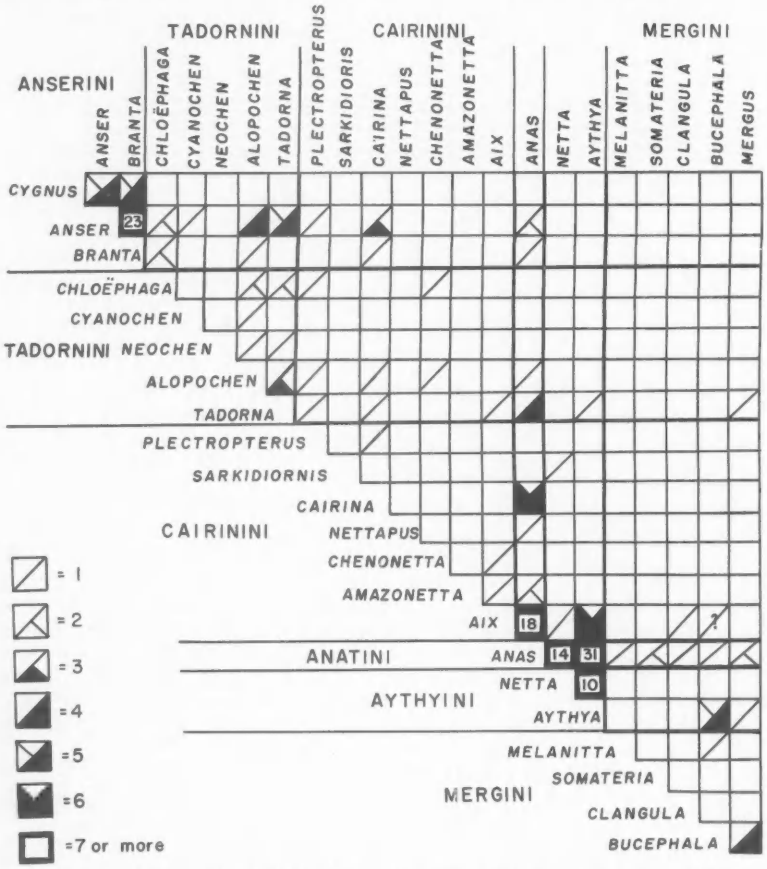

Fig. 7. Intratribal and intertribal hybrid combinations recorded among the genera of the Anatidae. Numbers indicated in key refer to total intergeneric combinations recorded.

markedly set off from the Anatinae. Likewise the stiff-tail group (Oxyurini) appears to be rather isolated from the other tribes. However, the rather obvious overall conclusion to be drawn from all these facts is that broad nomenclatural categories are greatly preferable to narrow ones in the Anatidae and that they help to emphasize actual biological relationships far better than does the highly "split" taxonomic hierarchy which is still in general usage as in the fifth edition of the American Ornithologists' Union Check-list.

CONCLUSIONS

A compilation of published and unpublished records of hybridization in the family Anatidae indicates that the genera and tribes proposed by Delacour and Mayr (1945) are well grounded. With but a single exception, that of the Cairinini, fertile hybrids resulting from intrageneric crosses and intratribal hybrids are more frequent than are intertribal combinations. The exceptional situation found in the Cairinini is largely the result of the Wood Duck (*Aix sponsa*), which has hybridized with 16 species of *Anas* but with only two species of its own tribe. This and other evidence clearly indicates that the correct position of the Cairinini is between the Tadornini and the Anatini, rather than between the Aythyini and the Mergini. Furthermore, most of the lumping of genera, especially in the Anserini, Anatini and Aythyini, as proposed by Delacour and Mayr, is well justified by the hybrid records.

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SEX RATIO OF NESTLINGS AND CLUTCH SIZE IN THE BOAT-TAILED GRACKLE

By ROBERT K. SELANDER

In most species of birds so far studied, the sex ratio among nestlings is nearly equal (Mayr, 1939; Lack, 1954:10; Hickey, 1955:347–348), but very unequal ratios have been reported for two species of icterids in Louisiana by McIlhenny (1937*a* and 1940). For the Boat-tailed Grackle (*Cassidix mexicanus*), McIlhenny claims a nestling ratio of 30 per cent males to 70 per cent females; and, for the Redwinged Blackbird (*Agelaius phoeniceus*), a nestling ratio of 77 per cent males and 23 per cent females is reported. These proportions are similar to those of adult and first-year birds of these species recorded by McIlhenny in his extensive trapping and banding operations in Louisiana.

Unbalanced sex ratios in adult vertebrate populations (tertiary ratios; see Mayr, 1939:157) are not unusual. In all species of birds for which adequate data are available, unbalanced tertiary ratios have been found to result from differential mortality in the two sexes beyond the nestling stage (Lack, 1954:108–113). It is, therefore, understandable that reports of any considerable deviation from the expected 50:50 ratio at fertilization (primary ratio), at hatching (secondary ratio), or among nestlings present problems of interest to population ecologists and geneticists alike. For this reason, it seemed desirable to re-examine the sex ratio in nestling Boat-tailed Grackles. In reporting an equal sex ratio among nestling Redwinged Blackbirds in Ohio, Williams (1940) has already cast doubt on the validity of McIlhenny's findings for that species. Anticipating the major conclusion of the present study, it may be stated that there is no indication of an unbalanced sex ratio among nestling Boat-tailed Grackles in Texas.

Data on clutch size, asynchrony of hatching, and egg and nestling mortality, obtained in the course of the study of sex ratios, have been included in this report; other aspects of the breeding biology and behavior of the Boat-tailed Grackle will be considered elsewhere.

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METHODS AND MATERIALS

All data herein reported were obtained from a single breeding colony in a giant live oak tree (*Quercus virginiana*) located along the Austin-Bastrop highway near the settlement of Montopolis, at the eastern limit of the city of Austin, Travis County, Texas (fig. 1). The tree held a total of 128 nests on April 29, 1959, most of which were placed 30 or more feet above the ground. On April 29, 18 nests were removed from the tree, and an additional 100 nests were examined and/or removed a week later, on May 6. If eggs were present, the number was recorded and, in most cases, one or more was broken to determine the degree of incubation. All nestlings were removed, dissected to determine the sex, and preserved, with gonads intact, for further study. In several cases where eggs were pipped, the young were removed from the eggs and the sex determined by dissection. All sex determinations were based on examination of gonads.

SEX RATIO OF NESTLINGS

The contents of 118 nests from the Montopolis colony are shown in table 1. It is evident that there is little synchrony in the breeding activities of the females; this is

typical of breeding colonies in the Austin region, but McIlhenny (1937*a*) reported close synchrony in colonies in marshes at Avery Island, Louisiana.

Thirty-nine nests contained young. The age of nestlings varied from a few hours to an estimated 17 days; weights ranged from 4.4 to 111 grams. The first young had fledged from this colony on April 23.

A total of 83 nestlings from 39 nests was sexed (table 2). The results: 47 males and 36 females. The observed deviation from an expected 50:50 ratio is not significant

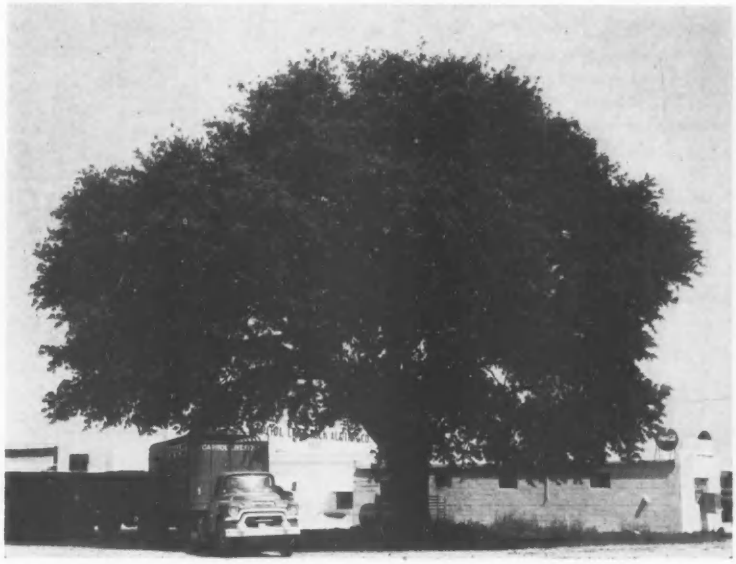

Fig. 1. Live oak near Montopolis, Travis County, Texas, used for nesting by a large colony of Boat-tailed Grackles; several males may be seen perched at the top of the tree.

(Chi-square=1.46, P=0.30). Considering only those nests in which three or four nestlings were present, an approximate primary ratio can be calculated, as shown in table 3. Males predominate in the sample, but the deviation is of doubtful significance (Chi-square=3.90, P=0.05). Thus, the data from the Montopolis colony provide no evidence of unbalanced primary or nestling sex ratios.

McIlhenny (1940:88–89) presented data on sex of young Boat-tailed Grackles from "137 nests in which the full complement of three young matured, as recorded in the five-year period 1935 through 1939, both inclusive." Assuming, as McIlhenny has claimed, that each set of three represents a full clutch (see beyond), these data yield a primary sex ratio of 1 male to 2.51 females (table 3). The sex ratio of nestlings from broods of various sizes, calculated from data from 89 nests examined by McIlhenny (1937*a*) in 1936, is similar to the primary ratio.

Although McIlhenny's data pertain to *C. m. major* and those of the present study to *C. m. prosopidicola*, I am unwilling to believe that the discrepancy in our findings can be accounted for on the basis of geographic variation in sex ratios. McIlhenny's determinations are questionable. He does not clearly state his method of sexing the nestlings,

but from his remarks it is clear that he did not examine gonads. With reference to the Boat-tailed Grackle and Redwinged Blackbird, he notes (1940:85) that, "In both of these species it is easy to distinguish the sex *by sight*, five or six days after hatching [italics mine]." And, referring to the Redwinged Blackbird, he states (*in* Williams, 1940:268): "The sex of the Gulf Coast Red-wing [*A. p. littoralis*] nestlings can be told

Table 1

Contents of 118 Nests of the Boat-tailed Grackle from the Montopolis Colony

Contents	April 29	May 6	Total
Nest in construction	1	1	2
Nest empty	2	22	24
1 egg	1	7	8
2 eggs	5	10	15
3 eggs	3	13	16
4 eggs	2	11	13
5 eggs	0	1	1
Small nestlings[1]	1	15	16
Large nestlings[2]	3	18	21
Young ready to fledge	0	2	2
Totals	18	100	118

[1] Largest nestling in brood under 40 gm.
[2] Largest nestling in brood over 40 gm.

Table 2

Sex Ratio in 39 Nests of the Boat-tailed Grackle from the Montopolis Colony

Nest ratio (males to females)	Frequency	Males	Females
1 to 0	2	2	0
2 to 0	4	8	0
3 to 0	3	9	0
3 to 1	1	3	1
2 to 1	3	6	3
2 to 2	2	4	4
1 to 1	13	13	13
1 to 2	0	0	0
1 to 3	1	1	3
0 to 3	0	0	0
0 to 2	3	0	6
0 to 1	5	0	5
1 to sex?	1	1	0
sex? to 1	1	0	1
Total	39	47	36

with certainty at any time after the fifth day from external appearances of the bill, torso, and general body size."

Since McIlhenny reported (1937*a*:275) that the juvenal plumages of male and female *C. m. major* are identical, we may presume that his sex determinations of nestling grackles were based on size differences. At least in *C. m. prosopidicola*, there is no sexual dimorphism in nestlings with regard to color or markings of the bill or other soft

parts. Moreover, the fact that McIlhenny does not indicate that he marked individual nestlings at hatching leads one to suspect that his determinations of sex in both grackles and Redwinged Blackbirds were made by comparing relative sizes of individuals in a nest. In a careful study of development of nestling Redwinged Blackbirds in Ohio, Williams (1940) has shown that the range of individual variation in size is sufficiently great that an error of one day in ageing might involve an error in sexing even after the eighth day from hatching. Likewise in the Boat-tailed Grackle, I doubt that sex determination of nestlings could be made on the basis of size before about eight days of age, even if the ages of the nestlings were accurately known. The fact that hatching tends to be asynchronous (see beyond) complicates the problem of sexing nestlings on the basis of size.

Table 3

Summary of Data on Sex Ratios Among Nestling Icterids

Region	Ratio	Number of nests	Number of nestlings	Male	Female	Percentages Male	Percentages Female
BOAT-TAILED GRACKLE							
Texas	Primary	9	31	21	10	67.7	32.3
	Nestling	39	83	47	36	56.6	43.4
Louisiana	Primary[1]	137	412	125	287	30.3	69.7
	Nestling[2]	89	205	70	135	34.1	65.9
REDWINGED BLACKBIRD							
Ohio	Primary[3]	35	119	57	62	47.9	52.1
Louisiana	Primary[2]	140	420	322	98	76.7	23.3

[1] McIlhenny (1940)
[2] McIlhenny (1937*a*)
[3] Williams (1940)

As noted previously, Williams (1940) was unable to confirm McIlhenny's claim of a strongly unbalanced sex ratio in nestling Redwinged Blackbirds. Data from the two studies are summarized in table 3; McIlhenny worked with *A. p. littoralis*, and Williams with *A. p. phoeniceus*. Unlike McIlhenny, Williams marked nestlings soon after they hatched and was able to determine ranges of variation in weight and tarsal length in the two sexes at different ages. His sex determinations based on size were checked in many cases by examination of gonads.

Herman (1938) has also claimed a preponderance of males among nestling Redwinged Blackbirds, but his ratio was derived from birds which were banded as nestlings but not sexed until they were trapped sometime after leaving the nest. Williams (1940: 275) has already pointed out the several sources of error in this method.

Using relative size as the criterion of sex, Fautin (1941*b*:217) estimated the sex ratio of nestling Yellow-headed Blackbirds (*Xanthocephalus xanthocephalus*) in Utah as 51 per cent females to 49 per cent males in one colony and 55 per cent females to 45 per cent males in another.

Tertiary sex ratios in icterids.—The interesting relationship between tertiary sex ratios and mating relationships in the Icteridae has been discussed by Mayr (1939:172) and Williams (1952:34–35). There is no evidence of a preponderance of one sex in non-colonial, monogamous species, but for several species which nest colonially or are parasitic, most if not all of which are polygamous or promiscuous, there are reports of markedly unbalanced sex ratios at breeding colonies or at banding stations.

A greater number of females than males has been reported in *Cassidix mexicanus* (33.1 per cent males among 5333 birds trapped in Louisiana, McIlhenny, 1940:88; and 2 or 3 females to 1 male at breeding colonies in Guatemala, Skutch, 1954:326); *Euphagus cyanocephalus* (ratios in breeding populations in California varied from 13 males and 14 females in 1943 to 18 males and 36 females in 1947, Williams, 1952:16); *Xanthocephalus xanthocephalus* (35 males to 83 females and 12 males to 40 females in two breeding colonies in Utah, Fautin, 1940:78; about 2 females per male at breeding colonies in Nevada, Linsdale, 1938:127–135); *Zarhynchus wagleri* (6 or 7 males and 39 females at a breeding colony in 1926, and 5 or 6 males and 29 females at the same colony in 1927, in Panamá, Chapman, 1928:135); *Gymnostinops montezuma* (females outnumbered males "several to one" at breeding colonies in Central America, Skutch, 1954: 294); *Cacicus cela* (a colony of 15 females and at least 8 males in Panamá, Skutch, 1954:308); and *Psomocolax oryzivorus* (females "always outnumbered the males by several to one," in Guatemala, Skutch, 1954:318). A surplus of males has been reported in the parasitic cowbirds, *Molothrus ater* (1902 males to 769 females trapped in Louisiana, McIlhenny, 1937*b*; "about three males to two females," Friedmann, 1929:173; see also Laskey, 1950); *Molothrus bonariensis* ("3 males to every 2 females," Friedmann, 1929:77); and *Tangavius aeneus* (Friedmann, 1929:326; but 1 male to 4 or 5 females in the breeding season in El Salvador, Dickey and van Rossem, 1938:540). In *Agelaius phoeniceus*, females outnumber males at the breeding colonies (Nero, 1956*a*:6), but McIlhenny (1940) reports 84.4 per cent males among 6480 birds trapped in Louisiana. In breeding colonies of *Agelaius tricolor*, Lack and Emlen (1939:229) found about 47 males to each 100 females.

Although there is reason to believe that some icterids have unbalanced tertiary sex ratios, it is doubtful that the actual proportions of the sexes in populations of any one species are accurately reflected in the information presently available. Mayr (1939: 157–159) has already noted some sources of error in determination of tertiary ratios in birds which are migratory or which show marked sexual dimorphism. To his discussion, it may be added that ratios based on counts of birds present at breeding colonies are especially subject to error in that first-year birds of one sex may be absent. For example, first-year male Boat-tailed Grackles do not hold territories at the breeding colonies and, with rare exception, do not breed, whereas first-year females normally breed. In the first half of the breeding season, first-year males rarely even visit the breeding colonies, although some may be present later in the season. Therefore, the fact that males are outnumbered 2 or 3 to 1 by females at breeding colonies in the Austin region, as they are also in Guatemala (Skutch, 1954:326), does not mean that the tertiary ratio is unbalanced to the same degree. In the Austin region, females probably outnumber males, but the actual ratio has not been determined.

First-year male Redwinged Blackbirds normally do not establish territories or breed, although they may visit the colonies (Nero, 1956*b*:141; Wright and Wright, 1944). Lack and Emlen (1939:229) note that at least some male Tricolored Blackbirds do not breed in the first year; and Fautin (1941*a*:117) found no first-year males at breeding colonies of the Yellow-headed Blackbird. It would not be surprising to find that first-year males of some other icterids, especially the large orpendolas, do not breed. Possibly the greater number of females than males in breeding populations may be due in large part to differing times of sexual maturity in the sexes, as suggested by Williams (1952: 35), Lack and Emlen (1939:229), Linsdale (1938:135), and others, rather than to an actual marked imbalance in the sex ratio. That nonbreeding of first-year males is not the only factor involved is indicated, however, by Williams' study (*loc. cit.*) of the Brewer Blackbird.

Trapping records may be no more reliable in determining tertiary ratios, for there are several sources of error in this method. In the nonbreeding season, flocks may be composed predominantly of one sex, and such flocks may differ not only in migrational pattern but in use of foraging and roosting localities within one area. Also, one sex may be more prone to enter a particular type of trap. In the Austin region, female Boat-tailed Grackles enter small box traps less readily than do males; and flocks of males frequently visit parks and other open areas in the city, whereas female flocks generally confine their activities to agricultural fields outside of town. McIlhenny (1940:89–90) also noted that the sex ratio of Boat-tailed Grackles trapped on a given day in Louisiana depended on whether a male or female live "decoy" was used to attract the birds to the trap.

CLUTCH SIZE

At the Montopolis colony, a total of 53 nests contained eggs but no nestlings (table 4). Eight nests contained one egg only; six of these eggs were fresh, one was decayed, and the condition of one was not determined. It may be assumed that a single egg never constitutes a complete clutch. In a total of 15 nests containing two eggs each, 10 sets were fresh, one set was well incubated, and the condition of four sets was not determined.

Table 4

Stage of Development of Eggs from the Montopolis Colony (April 29 and May 6)

Number of eggs in set	Number of sets	Fresh	Incubated	Addled	Undetermined
1	8	6	0	1	1
2	15	10	1	0	4
3	16	2	12	0	2
4	13	2	8	0	3
5	1	1	0	0	0
Total	53	21	21	1	10

From these data, I am inclined to infer that a set of two eggs may occasionally constitute a full clutch; and the well incubated set of two eggs has been considered in calculating clutch size, which is otherwise based on sets of three, four, and five eggs. Average clutch size in *C. m. prosopidicola* in the Austin region, based on 31 clutches, is 3.45 ± 0.11 ($\sigma = 0.62$). Clutches of three are most frequent, but those of four occur with almost equal frequency; clutches of two and five are unusual. These data pertain to first clutches of the season. Bent (1958:354) gives a range of clutch size of three to five for *C. m. prosopidicola* but does not present the data on which these figures are based.

Clutch size in the Boat-tailed Grackle varies geographically. Examining 49 nests of *C. m. mexicanus* at "Alsacia," Guatemala, Skutch (1954:342) found one with four eggs, 33 with three eggs, and 15 with two eggs. Average clutch size is 2.71 ± 0.07 ($\sigma = 0.50$) but, as the degree of incubation was not determined, there is some doubt as to how many of these sets represented completed clutches. According to McIlhenny (1937*a*: 282), in *C. m. major* at Avery Island, Louisiana, "the complement of eggs is invariably three," yet he mentions having seen one clutch of four! It is difficult to believe that there is so little variation in clutch size in *C. m. major*. Sprunt (1958:367) states that clutch size in *C. m. torreyi* varies from three to five, and he mentions finding "four on scores of occasions on the South Carolina coast and sometimes five. The latter number is unusual, the former all but the rule." Burleigh (1958:593) reports a set of four fresh eggs of

C. m. torreyi at Tybee Island, Georgia, where, however, the usual clutch size is said to be three (p. 595).

Asynchronous hatching.—Lack (1947:324–325; 1954:40–41) has proposed that asynchronous hatching and consequent inequality in size of the young in the nestling stage is an adaptation bringing the family size into adjustment with the food supply. In periods of food shortage, the smallest nestling receives no food and quickly dies, thus preventing weakening and possible death of the larger nestlings. Lack notes that marked asynchrony occurs only in species with comparatively long nestling periods, such as

Table 5

Decline in Brood-size with Increasing Age of Nestlings

	Mean weight of nestlings (grams)				
	4–18	19–38	39–68	69–98	109
Number of nests	14	4	11	9	1
Total nestlings	36	10	22	17	2
Males	17	6	13	9	2
Females	16	4	9	7	0
Sex?	3	0	0	1	0
Average number of nestlings per nest	2.6	2.5	2.0	1.9	2.0

hawks, owls, storks, and large passerines; but some degree of "spread" in hatching may also be advantageous in small passerines, such as wrens and tits (Armstrong, 1955:187).

In view of Lack's suggestion, it is worth noting that in most broods in the Montopolis colony there was marked individual variation in size (table 6). Much of this variation cannot be attributed to sexual differences in size and must result from asynchronous hatching and individual variation in rate of growth. In several broods of very small young, direct evidence of asynchronous hatching was obtained. The data from these broods suggest a "spread" of from 2 to 4 days, which is comparable to that reported for the Yellow-headed Blackbird (Roberts, 1909:377; Fautin, 1941*a*:109–110).

Skutch (1954:330) has reported asynchronous hatching in *C. m. mexicanus,* noting that "Only rarely, in nests with two eggs, did both hatch on the same day. More often, one egg hatched each day, so that in sets of three the hatching of all the eggs might require three days; or two might hatch on one day and the third on another day. In a few sets the eggs were marked as laid, and these hatched in the order of laying." With respect to laying, he notes (p. 328) that usually one egg was deposited each day until the set was completed; rarely two days elapsed between the laying of the first and second eggs in sets of two.

In *C. m. major* McIlhenny (1937*a*:282) notes that incubation begins when the second egg (in clutches of three) is laid.

Since hatching is asynchronous in this species, McIlhenny's (1937*a*:283) report of a high frequency of "infertile" eggs in nests of *C. m. major* becomes questionable, especially since his data were obtained by a count, on June 11, 1936, of unhatched eggs *in nests in which the young had just hatched.* He reported that "twelve out of nineteen nests examined contained each one egg that did not hatch, and three out of nineteen nests contained two eggs each that did not hatch." Twenty-five per cent of the 57 eggs laid in the nineteen nests supposedly were "infertile."

At the Montopolis colony, seven of 39 nests in which nestlings were present contained one egg in which embryonic development was not apparent; and two nests each held two undeveloped eggs. With one exception, all nests in which such eggs were found contained two nestlings; and the exceptional nest held three nestlings. I am not sure that

all unhatched eggs belonged to clutches from which the accompanying nestlings hatched, for two eggs taken from a nest containing two female nestlings several days of age (23 and 29 grams) appeared to be fresh. Excluding these two eggs and assuming that no undeveloped eggs were removed by the parent birds or were crushed or knocked from the nests by the nestlings, it is calculated that 6.7 per cent of all eggs layed were "infertile." Possibly a few of the undeveloped eggs examined were addled rather than infertile, but a distinction between these two conditions was not made. In view of McIlhenny's report, it should be emphasized that a 6.7 per cent loss of eggs due to "infertility" is not un-

Table 6

Individual Variation in Nestling Weight in Broods of the Boat-tailed Grackle

Nest number	Sex	Weight (grams)
38	♂ ♂	10.0, 8.8, 4.5[1]
	♀	6.5
76	♂	8.1
	♀	10.5
	sex?	5–6?[2]
1	♂ ♂	11.0, 6.0
	♀ ♀	10.0, 5.0
62	♂	12.3
	♀ ♀	23.0, 18.5, 8.5
105	♂	9.8
	♀	19.5
113	♂ ♂	28.5, 5.5
	♀ ♀	24.5, 12.5
8	♂ ♂	45, 39, 20
74	♂ ♂	77, 25
	♀	59
115	♂ ♂	62, 55, 36
46	♂ ♂	71, 41

[1] Advanced embryo taken from unpipped egg.
[2] Advanced embryo taken from unpipped egg; weight not recorded.

usually high for birds. In the Redwinged Blackbird, Smith (1943:198) found 4.3 per cent of eggs "infertile" (addled eggs included?); and a 6.1 per cent loss due to infertility and addling is reported for the Song Sparrow (*Melospiza melodia*) in California by Johnston (1956:267).

SURVIVAL OF EGGS AND NESTLINGS

The data on brood size provide a basis for estimating the magnitude of losses among eggs and nestlings. With increasing age, as indicated by increasing average weight of all nestlings in a nest, there is a steady decline in average brood size (table 5) from 2.6 in very young broods (4 to 18 grams average weight) to 1.9 in older broods (69 to 98 grams). Undoubtedly there is some further mortality among nestlings before they fledge, for birds in the 69 to 98 grams class probably are 5 to 10 days from fledging. In August, one to three months after fledging, first-year males average 185 grams; first-year females, 114 grams (Selander, 1958:373). The nestling period, as determined by Skutch (1954:245) for *C. m. mexicanus*, is 20 to 23 days.

Comparing figures for average clutch size and average number of nestlings in very young broods, it is calculated that no more than 75 per cent of the eggs hatch. This figure, it should be noted, applies only to successful nests, that is, to those in which one or more eggs hatched; it does not include any nests in which all eggs were destroyed

before hatching. The hatching success of *all* eggs laid probably is somewhat less than 75 per cent. Considering that 6.7 per cent of the eggs laid are "infertile," the hatching success of fertile eggs is calculated to be no more than 80 per cent.

Even assuming that all young of broods in the 69 to 98 grams class survive to fledge, it is apparent that no more than 77 per cent of the hatched young are fledged, or that no more than 58 per cent of the eggs laid give rise to flying young. All things considered, these figures, and that for hatching success, agree rather closely with those for *C. m. major*, the Common Grackle (*Quiscalus quiscula*), reported by Petersen and Young (1950), and the Redwinged Blackbird. Following 74 nests of *C. m. major*, McIlhenny (1937*a*) obtained data from which it can be calculated that 53 per cent of 222 eggs gave rise to flying young. In a major study of the Redwinged Blackbird in Illinois, Smith (1943: table 2, p. 190) found that 72 per cent of 1140 eggs hatched; 82 per cent of hatched young fledged; and 59 per cent of eggs gave rise to flying young. Rather lower values, however, are reported from other studies of this species (see review in Smith, *op. cit.*: 203–204), the Yellow-headed Blackbird (Fautin, 1941*b*), and the Brewer Blackbird (La Rivers, 1944: 437).

It is worthwhile noting that the data in table 5 reveal no significant shift in sex ratio among nestlings with increasing age. Similarly, in the Redwinged Blackbird there is no differential mortality in the sexes as nestlings (Williams, 1940: 276): among 94 young which successfully fledged, 47 were males and 47 were females. If in fact the tertiary ratios are unbalanced in these species, the imbalance must be attributed to sexual differences in post-nestling mortality.

Since this paper was submitted for publication, field studies in southeastern Texas and southwestern Louisiana have revealed that *mexicanus* and *major* are full species rather than races, for they are sympatric without interbreeding in a 65-mile-wide zone east of Houston and Galveston. Full details of this situation will be presented elsewhere, but it will be convenient to summarize additional information on sex ratios and clutch size at this time.

Three samples of nestlings are available from the zone of sympatry: a large series of *C. mexicanus prosopidicola*, a small series of *C. major major*, and a mixed sample consisting of young which have not been identified as to species; the latter probably includes approximately equal numbers of nestlings of the two species. Sex ratios are as follows:

	No. of nests	No. of nestlings	Male	Female
C. mexicanus prosopidicola	26	53	25	28
Mixed sample	14	32	14	18
C. major major	11	21	9	12

In none of these samples is there significant deviation from an expected 50:50 ratio, but the need for a larger series of *C. major major* is obvious. Combining these samples with that from the Austin region (table 2), we have a total of 189 nestlings of *Cassidix*; of these, 95 were males and 94 were females.

Clutch size in *C. mexicanus prosopidicola* was 4.45±0.16 (σ=0.74), based on 22 completed clutches collected between June 2 and 10, 1959, in the zone of sympatry. Thus clutch size is the same as in the Austin region. Data from eight clutches of *C. major major* yield a mean size of 2.88 (range, 2–3), confirming McIlhenny's report from Avery Island, Louisiana (see page 39).

SUMMARY

The sex ratio of nestling Boat-tailed Grackles (*Cassidix mexicanus prosopidicola*) was determined by dissection of 83 nestlings from a large breeding colony in the Austin

region, Texas. Neither the primary nor the nestling ratio showed significant deviation from an expected 50:50 ratio. A previous report by McIlhenny of a sex ratio strongly unbalanced in favor of females among nestlings in Louisiana is attributed to an unreliable method of sex determination.

Evidence of unbalanced tertiary sex ratios in the Boat-tailed Grackle and other icterids is reviewed, and several sources of error in determination of tertiary ratios are pointed out.

Clutch size in *C. m. prosopidicola* in the Austin region averages 3.45±0.11; clutches of three are most frequent but those of four occur with almost equal frequency; clutches of two and five are unusual.

Marked variation in size among nestlings of the same brood is attributed in part to asynchronous hatching. McIlhenny's earlier report of a high frequency of "infertile" eggs in nests of *C. m. major* is questioned. In the Austin region, an estimated 6.7 per cent of eggs laid are infertile or become addled.

Comparing average clutch size and average number of nestlings in very young broods, it is estimated that hatching success is no greater than 75 per cent. With increasing age, there is a decline in average brood size from 2.6 nestlings in very young broods to 1.9 in older broods. From these data, it is estimated that no more than 77 per cent of hatched young are fledged and no more than 58 per cent of eggs laid give rise to flying young.

Because the nestling sex ratio of the Boat-tailed Grackle is balanced and there is no significant shift in sex ratio with increasing age of the nestlings, any imbalance of the tertiary ratio in this species must be attributed to differential mortality in the sexes following the nestling period.

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SEXUAL DICHROMATISM IN TWO SPECIES OF THE COLUMBIDAE

By WILMER J. MILLER

It is obvious that many birds exhibit sexual dimorphism of color. But the causal mechanisms resulting in sexual dichromatism have been well demonstrated for only a few species such as chickens and finches. Sex hormones control the plumage color and form in the brown leghorn (Greenwood and Blyth, 1938). Witschi (1935, 1937) and students have shown that within the weaver finches, three kinds of control are involved: sex hormones, gonadotrophic hormones, and genetic constitution.

The auto-sexing varieties of chickens and geese (Hutt, 1949; Quinn, 1939) and of domestic pigeons reveal sex dichromatism by the time of hatching and in the first plumage. Auto-sexing refers to a genetic method of detecting sex in birds and requires a sex-linked gene with dosage effects easily detected early in the birds' development. A wild species exhibiting auto-sexing is the Snow Bunting, *Plectrophenax nivalis* (Pitelka, personal communication). Auto-sexing is difficult to explain by known hormonal mechanisms, and relatively direct gene control of such sexual dichromatism is indicated (Hollander, 1942).

Among the approximately 14 species of doves in the genus *Streptopelia* only one, the Dwarf Turtle Dove (*Streptopelia tranquebarica*), exhibits marked sexual dichromatism. This dove is native to the Philippines, southeastern Asia, and India. Immature and female *tranquebarica* are "gray." The mature male has a bluish head, with the color extending to the neck ring, and a reddish brown "back."

Several auto-sexing pigeons and *tranquebarica* were available from a pigeon colony housed in a barn by the Department of Genetics at the University of Wisconsin, Madison, Wisconsin, and since they seemed to represent opposite extremes of early and late dichromatism within the Columbidae the following experiments with hormones were conducted.

The data on the domestic pigeon or Rock Dove (*Columba livia*) were collected in connection with another study (Miller and Wagner, 1955) in which the hormones were donated by Dr. W. H. McShan and the implants and some of the injections were made by Frederic H. Wagner.

MATERIALS AND METHODS

The sex of the mature Dwarf Turtle Doves was ascertained by their color. This diagnosis agreed with the method of sexing described by Miller and Wagner (1955) and Hanson (1953). Female doves were injected with testosterone propionate, the males with estradiol benzoate, and the controls were injected with sesame oil (the diluent for the hormones) according to the following plan:

Dove	Sex	Daily injection intramuscularly
D801.136	Male	0.1 ml. sesame oil
D801.134	Female	0.1 ml. sesame oil
D801.112	Male	0.1 ml. estradiol benzoate (0.166 mg.)
D801.140	Female	0.02 ml. testosterone propionate (0.1 mg.)
D801.171	Female	0.08 ml. testosterone propionate (0.4 mg.)

On the third day after injections were begun, some feathers were plucked from the right half of the bird's head and from the right wing. The wing feathers plucked were lesser secondary and marginal coverts. Eleven days after plucking, the last injections

were given to the controls and to D801.171 since the regenerating feathers were already showing their color. D801.112 and D801.140 received their last injections 20 days and 28 days after plucking, respectively, since their feather regeneration was slower. D801.171 died 18 days after plucking, but most of the regenerating feathers were about two-thirds regrown and were saved. The head feathers of D801.112 were extremely delayed in regeneration and very probably had no effect of the injected hormone since the injections had been stopped at least 30 days previously.

The feathers grown before and after treatment were compared and colors checked with Ridgway's "Color Standards and Color Nomenclature."

Auto-sexing strains of the domestic pigeon have been made utilizing the mutant "faded," St^F, which has been described by Hollander (1942). The faded gene is sex-linked and causes sparse down and absence of pigment on the bills of homozygous males just hatched but permits nearly normal down and pigment on the bills of hemizygous females. The first feathers of the homozygous faded male squabs are white with rare flecks of color, usually black but often reddish in color. The first plumage of a homozygous faded male does not differ in color from later plumages except that the flecks may become more numerous and larger. The hemizygous faded female has nearly normal-colored plumage but has a "washed out" appearance.

Five-week-old, opposite-sexed siblings from a pure line of faded pigeons received intramuscular injections daily of the opposite sex hormone—0.25 ml. of testosterone propionate was given the female (equivalent to 12.5 mg. per injection and equal on a weight basis to 0.04 ml. or 0.2 mg. if given to a Dwarf Turtle Dove), and 0.5 ml. of estradiol benzoate (0.83 mg.) was given the male.

Some tail feathers, secondaries from the right wing, and feathers from the back were plucked from each bird at the first injection of hormone, and these of course were saved for comparison with the regenerated feathers. Injections continued for 18 days until the regenerating feathers were nearly fully regrown.

Two additional males six weeks of age were implanted with diethylstilbesterol pellets; they were similarly plucked and the feathers compared.

RESULTS

Several birds other than those listed were given different doses of the hormones at the beginning of the experiment. These birds died in a Newcastle epidemic before results could be obtained (see Hanson and Sinha, 1952, and Miller and Wagner, 1955).

The faded female of *Columba livia* injected with testosterone propionate developed typical male cloacal papillae during the first week of injections, that is, at six weeks of age (Miller and Wagner, 1955). Papillae are not ordinarily distinguishable until males are four to six months old. No color change was observed in any of the regenerated feathers of the injected or pellet-implanted pigeons when these were compared to the original plucked feathers. There was a slight increase of black flecks in the males' feathers but this is normal for such males.

All Dwarf Turtle Doves receiving the "reverse" sex hormone showed intermediate color and pattern of feathers tending to be much more like the opposite sex. As Salomonsen (1940) has indicated, the influence of hormones on feather color and pattern is not "all or none" but often may be intermediate. New feathers of the control birds D801.134 and D801.136 were one grade darker than the previous old feathers, except for the male wing color which showed little difference. This kind of change had been noticed for new feathers of this and other species of doves, probably resulting from sun fading or weathering of the older feathers.

Comparisons of the feather color of the Dwarf Turtle Doves are given in table 1.

Table 1

Results of Reversing Sex Hormone on *Streptopelia tranquebarica*

Specimen number and sex	Standardization of untreated feathers	Standardization of regrown feathers
D801.134 ♀ control	Wing: army brown edges deepening gradually to deep mouse gray in the proximal half of the feather	natal brown (next grade to army brown) deepening to deep mouse gray
	Head: deep mouse gray	dark mouse gray lightening to deep mouse gray
D801.136 ♂ control	Wing: Hay's brown changing abruptly to deep mouse gray in the proximal half of feather	Hay's brown changing abruptly to deep mouse gray (no change)
	Head: dark gull gray	slate gray (next darker grade to dark gull gray)
D801.112 ♂ 0.1 cc. estradiol	Wing: colors same as in D801.136	Hay's brown *edges* only, grading* to deep mouse gray
	Head: colors same as in D801.136	(delayed regeneration of feathers) no change, dark gull gray
D801.140 ♀ 0.02 cc. testosterone	Wing: army brown edges but larger than in D801.134	very large area of the edges Hay's brown with an *abrupt change* to deep mouse gray in the proximal part of the feather
	Head: color same as in D801.134	*dark gull gray*
D801.171 ♀ 0.08 cc. testosterone	Wing: colors same as in D801.134	feathers "two-thirds" regrown; *Hay's brown* slightly "peppered" with and deepening to deep mouse gray
	Head: colors same as in D801.134	no feathers; bird died

* Italics indicate hormonal influence.

Standardization was made twice under fluorescent and "ordinary" bulb lighting using Ridgway's "Color Standards and Color Nomenclature."

DISCUSSION

In spite of the loss of some birds before results could be obtained, it has been demonstrated that sexual dichromatism in *Streptopelia tranquebarica* is under the immediate control of the sex hormones. In the auto-sexing *Columba livia,* "direct" gene action without sex hormonal influence is indicated as the cause of sexual dichromatism.

It has been shown that sex hormones control the plumage form and color in brown leghorns (see Juhn, Faulkner and Gustavson, 1931; Domm, Gustavson and Juhn, 1932; and Greenwood and Blyth, 1938). Sex hormones alone do not explain sexual dichromatism in all birds even for those which show marked hormone influence (Danforth, 1937). Half-and-half or sectorial mosaics, male on one side and female on the other, with regard to color are known (Hollander, 1944), and species showing seasonal plumage changes complicate the problem. Witschi (1935) and students have explained some of the complications in their work on weaver finches, in which a complex interaction of sex hormone, gonadotrophic hormone, and genetic constitution is shown. Also see Miller (1935) for some effects of thyroxin.

Much work remains to be done to clarify the mechanisms of sexual dichromatism. For example, what is the genetic basis for the differences of *S. tranquebarica* from other species of *Streptopelia* that enable it to exhibit sex hormonal control of its sexual dichromatism? Certainly the genetic interactions with the environment both internal (especially hormones) and external can be complex.

SUMMARY

Sexual dichromatism in two species of the Columbidae exemplify the two extreme types of control: "direct" genetic control, and sex hormonal control.

Reversal of the predominant sex hormone by injection of testosterone propionate or estradiol benzoate in mature individuals of the Dwarf Turtle Dove (*Streptopelia tranquebarica*) resulted in a corresponding change in the feather color in the head and wing which in this species shows sexual dichromatism. Control *tranquebarica*, male and female, injected with sesame oil, showed no change.

Reversal of the predominant sex hormone in the auto-sexing domestic pigeon (*Columba livia*) had no effect on the plumage color.

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INTERRELATIONS OF ABERT AND BROWN TOWHEES

By JOE T. MARSHALL, JR.

INTRODUCTION

This paper summarizes observations on the relations between the Abert Towhee (*Pipilo aberti*) and the Brown Towhee ("Canyon Towhee," *P. fuscus mesoleucus*) in an environment at Tucson, Arizona, inhabited by both. Over most of their ranges these two similar species are separated into different habitats and geographic areas, so that their concurrence at Tucson provides a unique opportunity to examine competition between sibling species and to understand the behavioral differences which maintain their reproductive isolation.

Purely for convenience I should like to depart from the very commendable usage of the American Ornithologists' Union Check-list (1957), in which subspecific vernacular names are abandoned, by adhering to the name "Canyon Towhee" for the race of the Brown Towhee at Tucson, and "California Towhee" for the races in California (especially *Pipilo fuscus petulans* at Berkeley, California) with which comparisons will be made. These races are so unlike that it is well to refer to them by different names and to maintain for the group as a whole the term "brown towhees," as used by Davis (1951) to include all brown members of the genus *Pipilo*: *P. fuscus, P. aberti,* and *P. albicollis.* In the field, the Canyon Towhee is not even recognizably the same species as the populations of California; it is rather the Abert Towhee which in form, posture, voice, and abundance seems the counterpart of the birds of coastal California.

Previous works or concepts bearing importantly on our topic include the extensive nesting studies of the two species on Rillito Creek at Tucson by Bendire (1890). He found that their nests were segregated; those of the Abert Towhee were confined to the thickets of the creek bottom, and the nests of the Canyon Towhee were placed from 100 yards to a mile from the bed of this creek. Miller (1955:10) cites the two as examples of related species which have unquestionably achieved reproductive isolation in nature. Davis (*op. cit.*) has written a definitive work on the distribution, ecology and taxonomy of the entire brown towhee group, and Marshall and Johnson (in press) have summarized the life history of the Canyon Towhee.

Dawson (1954), impressed by the Abert Towhee's ability to live near the presumed limit of its tolerance in the extremely hot Imperial Valley of California, found nevertheless that it had no peculiarities of heat and water regulation; indeed it did not differ importantly from the California Towhee in those aspects of its physiology, although it made behavioral adjustments such as keeping in the shade at midday. Further investigations on the California Towhees include Quaintance's (1938, 1941) study of voice and territory, Davis' (1957) analysis of feeding behavior, and Childs' study for "Bent's Life Histories" (in press). The latter incorporates the remarkable banding results of Harold and Josephine R. Michener.

ACKNOWLEDGMENTS

I wish to thank the National Science Foundation and the Sigma Xi Committee on Awards for making possible this study. I am also indebted to the Papago Tribal Council for my use of several abandoned farms on the San Xavier Reservation as the principal study area, to Mr. and Mrs. William H. Woodin III for use of their property on Sabino Creek as an additional site for banding, and Dr. and Mrs. John Davis, Mrs. Ina L. Foss, Patrick J. Gould, and R. Roy Johnson who assisted in banding or in other phases of the study.

THE STUDY SITES

The study site at the San Xavier Reservation is situated in the bottomland of the Santa Cruz River, 10 miles south of Tucson. Mesquite (*Prosopis juliflora*) composes a closed woodland with an understory of gray-thorn (*Condalia lycioides*) within which are abandoned farms grown to weeds and Johnson grass. Tall mesquites and dense elders

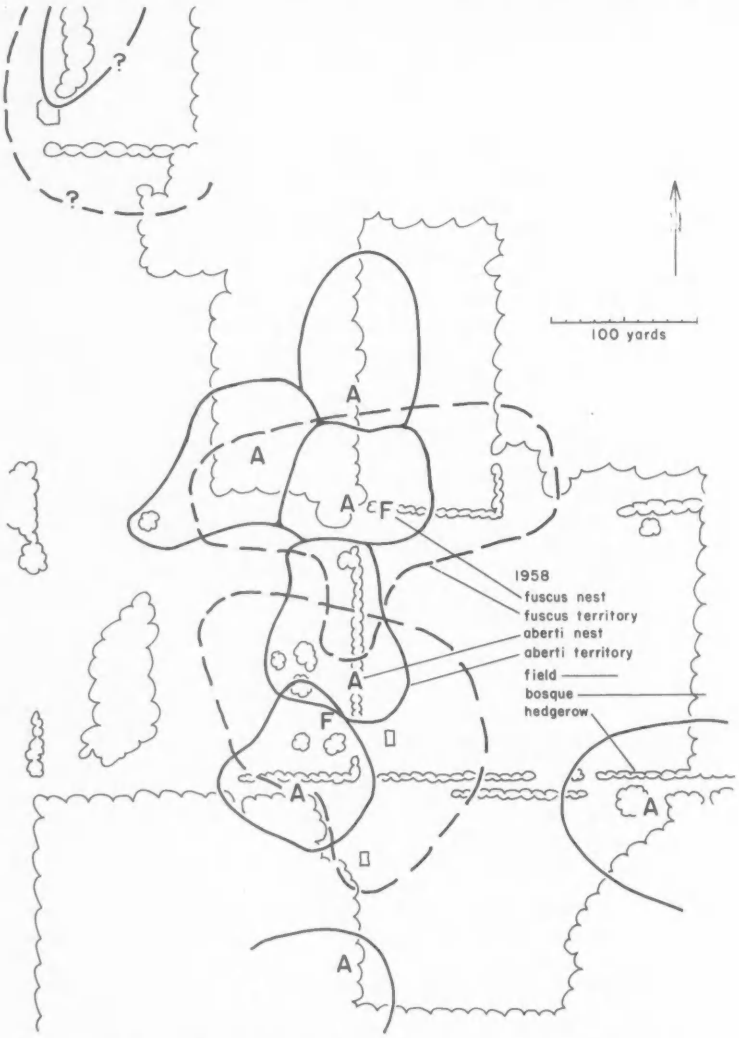

Fig. 1*a*. Territories and nests of towhees at San Xavier Reservation, 1958. There were doubtless more nesting Abert Towhees than shown.

(*Sambucus mexicana*) line the fence rows. The period of study covered at this area was 175 days from late September, 1957, to May, 1958, and late September, 1958, to May, 1959. The average time spent was 3½ hours per day. Seventy fully grown Abert Towhees and 17 Canyon Towhees were banded within 50 acres in the course of both winters. As shown in figure 1, only a few of these birds comprised the breeding populations of established pairs on territories.

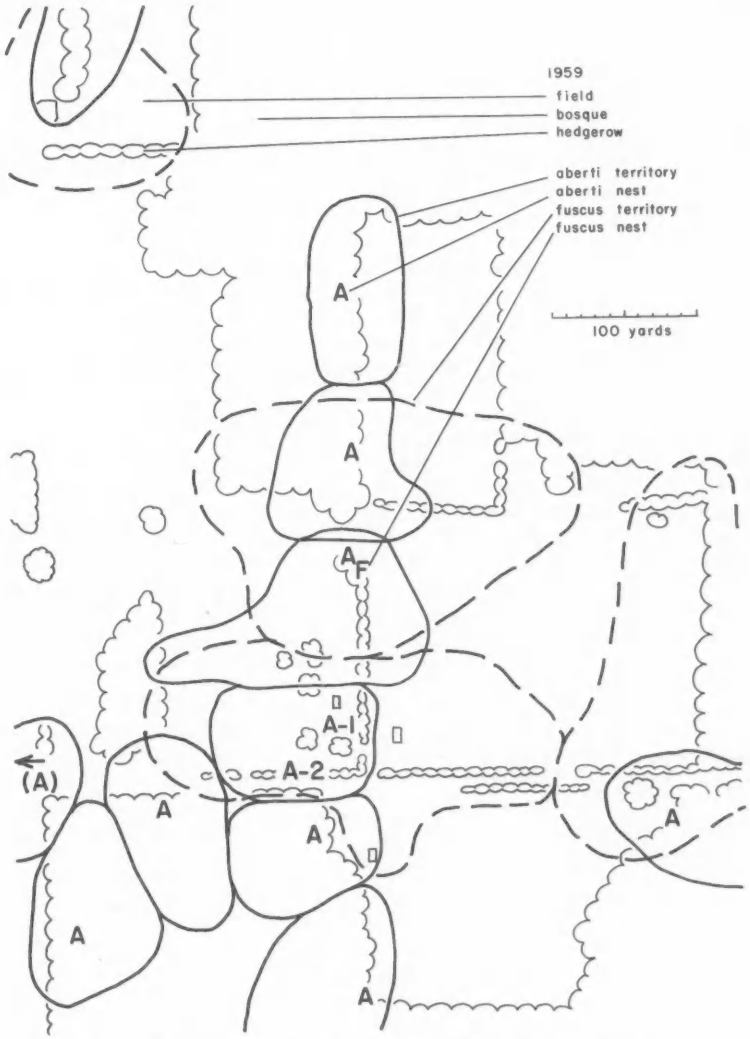

Fig. 1*b*. Territories and nests of towhees at San Xavier Reservation, 1959.

Ten miles east of Tucson, at Sabino Creek, which flows seven months of the year, tall mesquites, forming an interrupted canopy, dot the flood plain. The spaces among them are filled with weeds, sunflower patches, and catclaw acacia (*Acacia Greggii*). Along the stream and nearby are tall sycamores (*Platanus Wrightii*), ash (*Fraxinus velutina*), and elders. The flood-plain vegetation is abruptly contiguous with a contrasting desert vegetation of saguaro (*Carnegiea gigantea*), cholla (*Opuntia fulgida*), paloverde (*Cercidium microphyllum*) and creosote bush (*Larrea tridentata*). Thirty-nine days were spent observing in October, 1957, February to May and one day of June in 1958, and a day or two in March and May, 1959, at this locality, where 9 fully-grown Abert Towhees and 7 post-fledgling Canyon Towhees were banded in 23 acres. Nesting territories are shown in figure 2. There were no substantial observations for the months from June to September at either study site. A few days were devoted to study of California Towhees at the Hastings Reservation near Carmel, California, in December, 1957, and this species was also studied on the University of California campus at Berkeley in April, 1959. Because of significant behavior at dawn, observations commenced on 99 of the total of 219 days at that early hour.

METHOD

During the first winter, mist nets and Bailey traps placed under bushes were virtually selective for towhees, which were easily banded. Grain placed in gallon jars provided attraction to certain spots favorable for observations during parts of the winter. But during the winter of 1958–59, in the second year of the abandonment of the farms, a family of six peccaries moved in and raised such havoc with grain and traps that it was impossible to leave unset but baited traps in position. Other species were more vulnerable than towhees to the non-prebaited traps and their use had to be abandoned. Netting, with special nets designed for slow-flying birds, was made arduous and relatively unrewarding because of the time needed to extricate the great numbers of wintering birds of other species. Again because of the peccaries, feeders were discontinued, and grain was spread in selected areas only when it was desired to identify certain groups of individuals. Towhees were banded with United States Fish and Wildlife Service bands and with colored plastic rings. The latter were supplied by A. C. Hughes of Middlesex, England. Experience showed that it was necessary to use identical color patterns on both legs, even if it meant using four bands per bird in addition to the one aluminum band. It is not pretended that this study caused no interference with the normal life of the birds. It is sufficient now to mention that netted towhees proved wilder and harder to observe than their unbanded fellows, which necessitated studying them with a 15-power telescope while writing observations in the field notebook. Best results were obtained from a portable blind placed on top of an abandoned house, which location afforded a view of three feeding stations and of a well frequented by the birds.

The trapped or netted birds were immediately weighed, measured, banded, and released. Measurements of wing and tail, in conjunction with age differences in plumage, when compared with the data of Davis (1951), permitted a probable determination of the sex of the bird, which in most cases agreed with subsequent observations or captures in which sex was revealed by behavior, song, cloacal protuberance, or brood patch.

INTERRELATIONS IN AREA OF OVERLAP

ECOLOGIC INTERRELATIONS

Population.—At Sabino Creek the number of pairs of Abert and Canyon towhees on breeding territories (fig. 2) reflects a thin population of both species, normal for the Canyon Towhee, and subnormal for the Abert Towhee. The mesquite and riparian growth is too open and too discontinuous to permit a dense population of Abert Tow-

hees, which are limited to that growth. But the openings allow a substantial number of Canyon Towhees to share the habitat with them. The Canyon Towhees are evenly spaced in desert vegetation off to the sides of the river, and similar spacing is maintained on the flood-plain district of overlap with the Abert Towhee. The result is an occurrence of the two species there in about equal numbers. Although the Canyon Towhees fre-

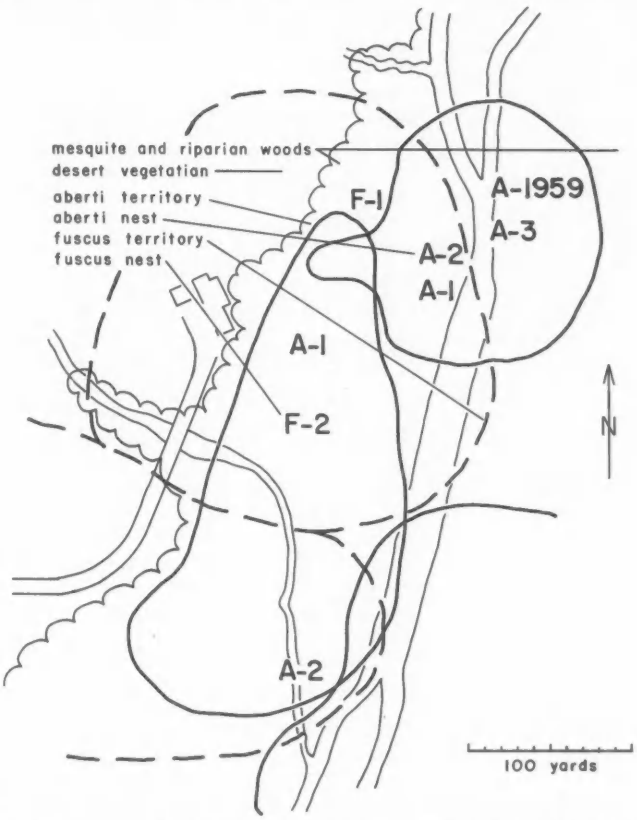

Fig. 2. Territories and nests of towhees at Sabino Creek, 1958. Scalloped line represents boundary between desert vegetation (left) and riparian or mesquite growth (right). Numerals indicate successive nests of same pair.

quently visit the desert vegetation at the sides, which the Abert Towhees never do, there is no discernible difference in their utilization of the flood-plain area itself.

At the San Xavier Reservation the closed mesquite bosque provides optimum habitat for a dense population of Abert Towhees. But the openings and farms hewn from this woodland admit a normal thin population of Canyon Towhees as well (fig. 1). Without these fields to provide necessary edge environment (between openings for foraging and bosque margin and hedgerows for hiding and nesting) the Canyon Towhee would not

exist there, nor would it be in extensive contiguity with the Abert Towhee under natural conditions except at the base of a small hill nearby (Saguarito Butte), at the side of the riverbed. Here a few pairs of Canyon Towhees on the rocky slope of cacti and paloverde confront a few Abert Towhees in the riparian and mesquite growth. Away from this butte, remnants of the original bosque margin show a gradual depression in stature of the mesquites on land gently sloping upward toward the desert. This area of mere bushes tapering into flat open hot desert is a no-man's-land for both species.

Utilization of habitat.—These considerations leave us quite unprepared for the startling fact that at the study site the two species actually overlap and utilize indiscriminately the bosque as well as the farms and hedgerows. Indeed, we should expect the Abert and Canyon towhees to cleave respectively to the bosque and farms, in line with their habitat preferences elsewhere. Actually, hundreds of locality records of marked individuals plus the summary of 165 descriptions of feeding behavior (table 1) show that both species forage in the fields and in the bosque. The only qualitative difference is that Canyon Towhees were not found in the interior of bosque beyond about 30 yards from the edge, although some pairs would cross beneath tongues of bosque 80 yards wide. Abert Towhees on the other hand can always be found far in the interior. Canyon Towhees frequently entered or fed on and around the adobe farm houses which were shunned by Abert Towhees. Since most of my observations were made along the bosque edges, ignoring a substantial number of Abert Towhees whose activities were centered in the bosque interior, the summary of feeding observations, essentially the same for both species, clearly shows that as far as the overlapping segments of the populations are concerned, the two species use the same environment in the same way. The Canyon Towhee, one of the most secretive of Arizona birds, thus finds the bosque a congenial place for secluded feeding.

Foraging method.—Table 1 shows that the Abert Towhee is proportionately more often observed scratching than is the Canyon Towhee. Although this may be a direct result of the greater ease of observing the Abert Towhee, it bears out Davis' (1957) conclusions based on structural considerations that the Abert Towhee is somewhat better adapted for scratching than is the California Towhee. Of particular interest in this connection is the Abert Towhee's propensity for "above-ground scratching." It has been seen scratching through several inches of piled leaves and twigs, and it scratches on the top of accumulations of twigs placed like collars by high water about the bases of streamside trees. One Abert Towhee may originally have been looking for nesting material while picking at the bark of a mesquite trunk eight feet above ground. But it extracted and ate a large insect and then made a thorough search of the trunk for more. During this search, while climbing about the trunk like a wren or nuthatch, it scratched several times while somehow maintaining its position, with head inclined downward, against the vertical trunk. The Abert Towhee, California Towhee, and Green-tailed Towhee are known to scratch at above-ground feeding stations, where they scatter the seed as if the scratching instinct is so inextricably wound up with feeding that it cannot be halted when inappropriate. As to bark feeding by the Abert Towhee, Brewster (1882) reports, "I have seen them hunting insects in the bark of large trees in a manner similar to that of wrens."

Outside of the study area, a pair of Abert Towhees was seen foraging in niches on the side of a 20-foot high vertical riverbank, and a pair of Canyon Towhees fed on the anthers of saguaro blossoms at the top of the tree. Such incidents though insignificant numerically, are mentioned not as anecdotes, but for the purpose of rounding out our picture of the capabilities in foraging by these birds, both rather highly specialized for feeding by picking up from the ground food which has been exposed by repeated scratch-

ing on one spot with both feet kicking simultaneously. It may be said then that the feeding of the two is essentially the same, with the more easily observed Abert Towhee showing somewhat greater versatility, more scratching, and more "above-ground feeding."

Table 1

Summary of Individual Observations of Feeding

ABERT TOWHEE (54 per cent scratch)	BOSQUE: 28 per cent (Includes dense growth at Sabino Creek)		OPEN: 72 per cent (Road, bare ground, plowed field, under bushes and weeds)	
	Scratch	Not scratch	Scratch	Not scratch
Ground, from or at				
Seeds (mostly)	12	6	34	16
Cow, horse dung	2	1	4	1
Reaching up for seeds, buds, grass shoots	....	2	....	4
Collecting caterpillars for young off weeds	....	....	....	8
Insects	1	1	....	1
In holes	....	1	....	2
Running or flying after insects	....	....	....	3
Above Ground				
Drift litter and piles of twigs	2	....	1	....
Seeds on elevated feeder and up on rock	....	....	2	1
Insects in bark of trunks and branches in trees	2	....	....	1
Insects off leaves of bush	....	....	....	1
Berries on bushes	....	1	....	....
Mesquite flower-buds in crown foliage	....	....	....	1

BROWN TOWHEE (37 per cent scratch)	BOSQUE: 26 per cent (Includes dense growth at Sabino Creek)		OPEN: 74 per cent (Road, bare ground, plowed field, under bushes and weeds)	
	Scratch	Not scratch	Scratch	Not scratch
Ground, from or at				
Seeds (mostly)	5	6	11	18
Cow, horse dung	....	....	....	1
Reaching up for seeds, buds, grass shoots	....	1	....	2
Insects	....	1	1	2
In holes	....	....	1	1
Running or flying after insects	....	1	....	....
In and on buildings and side of gully	....	....	2	....
Above Ground				
Buds of hackberry in crown foliage	....	....	....	1

BEHAVIORAL INTERRELATIONS

Interspecific contacts.—If two similar species with nearly identical feeding behavior and nesting requirements share the same habitat, it is obvious that each takes food and nesting sites which could be utilized by the other; in other words, they compete. We would expect them to recognize each other as competitors and to make behavioral adjustments, in the form of some sort of antagonism, toward each other. All the observed contacts between Abert Towhees and Canyon Towhees at the two study areas are summarized in table 2, where intraspecific and intergeneric conflicts are also indicated for comparison. These show that there is no more aggression, in the form of supplanting attacks and chases at food, between the two species of towhees than there is between them and other genera with which they do not seriously compete. The figures bear out

the persistent impression from field work that the Abert and Canyon towhees pay practically no attention to each other, in spite of feeding and nesting in the same locations. One reason for this is the singularly retiring and unobtrusive demeanor of the Canyon Towhee, which slips along silently through the dense growth of weeds, hedgerows, and bosque and scarcely comes to the attention of the Abert Towhee, let alone of the bird student!

Some of the items in table 2 require explanation. I use the term "group" for aggregations of towhees or of towhees with other seed eaters which feed on the ground. The

Table 2

Instances of Inter- and Intra-specific Contacts

a. Contacts between Abert and Canyon towhees, total 84

No conflict; together at		*Conflicts (attacker indicated by A=aberti; F=fuscus)*	
Food	33	Supplanting attack at food (winter only)	A 6 F 4
Mixed group	13	Fight (territorial?)	A 3 F 5
Same bush or tree	11		
Water	5		
Distressed fledgling	1		
Companionship?	3		

b. Hostilities among Abert Towhees, in 188 contacts

No conflict; together in		*Conflicts, same species*	
Group	31	Supplanting attack or chase from food	24
Breeding territory (two pairs or families being fed)	6	Sexual fight	8
Conflicts, other genera		Territorial squeal-duets	48
Supplanting attack at food		Territorial fights	47
Abert Towhee attacks			
Cardinal	3		
Pyrrhuloxia	5		
Green-tailed Towhee	1		
White-crowned Sparrow	5		
Abert Towhee attacked by			
Ground Dove (threat)	1		
Cardinal	1		
Threat, chase or fight elsewhere			
Abert Towhee attacks			
Cardinal	1		
Pyrrhuloxia	4		
Green-tailed Towhee	1		
White-crowned Sparrow	2		

c. Hostilities among Canyon Towhees, in 36 contacts

No conflict; together in		*Conflicts, same species*	
Group	13	Sexual fight	1
Breeding territory, families being fed	2	Competitive singing	4
Conflicts, other genera		Territorial squeal-duets	8
Supplanted at food by		Territorial fights	1–3?
Curve-billed Thrasher	1		
Cardinal	1		
Pyrrhuloxia	1		
Canyon Towhee chases or threatens elsewhere			
Cardinal	1		
House Finch	1		
Lincoln Sparrow	1		

group may consist of nearly a dozen Abert Towhees, two or three Canyon Towhees, many Cardinals (*Richmondena cardinalis*), Pyrrhuloxias (*Pyrrhuloxia sinuata*), White-crowned Sparrows (*Zonotrichia leucophrys*), Green-tailed Towhees (*Chlorura chlorura*), and Lincoln Sparrows (*Melospiza lincolnii*), with a scattering from time to time of Crissal Thrashers (*Toxostoma dorsale*), Curve-billed Thrashers (*Toxostoma curvirostre*), Rufous-sided Towhees (*Pipilo erythrophthalmus*), Rufous-winged Sparrows (*Aimophila carpalis*), and Ground Doves (*Columbigallina passerina*). Neither in the mixed assemblage nor in a pure group of Abert Towhees is there any persistent coincident direction of movement nor sign of flock organization. Supplanting attacks (see table 2) by certain dominating individuals seem to be made without reference to species, or individuals; however, further study may reveal a rudimentary "peck-order." These birds merely gather at food supplies, just as much at favored roadsides or corners of fields as at the artificial feeding stations. Generally the Cardinals and Pyrrhuloxias come first, and their loud cracking of the seeds signals other birds that food is at hand. Most of the "groups" of Canyon Towhees are trios from the winter of 1958–59; in the previous year only widely-spaced pairs were found, which rarely came into contact.

Under the dubious heading of "companionship," I refer first to an instance of a lone Canyon Towhee which joined a pair of Abert Towhees for a few minutes within the dense bosque. The second observation, on November 8, 1958, concerns a solitary individual of each species that stayed a foot or two apart and joined forces at successive foraging spots for at least a half hour; the Canyon Towhee led. Finally, on May 14, 1959, a pair of Canyon Towhees, feeding in short Bermuda grass, was joined for five minutes by a lone immature male Abert Towhee. The latter had a small territory there in habitat too open for the species, which may be the reason he could not attract a mate. His sense of ownership was evidenced by his calls and brief songs whenever other Abert Towhees passed along this hedge (from one end of the field to the other), by alarm notes uttered whenever a human observer came near the particular elder trees in which he sat, and by persistently doubling back to return to this spot when one attempted to drive him farther along the hedge. At the approach of the Canyon Towhees, with no other Abert Towhees in the vicinity, this young Abert hopped directly up to them and fed within a few inches of them, as if he were actually seeking companionship. There was plenty of other Bermuda grass in which to forage, and we may assume that he would not have come so close to the Canyon Towhees unless definitely attracted.

A juvenal Canyon Towhee which I caught after it left the nest uttered a piercing squeak which summoned up its own parents and an Abert Towhee, which "peeped" in alarm. There were three additional instances of response to calls of the opposite species. Two pertain to a lone Canyon Towhee which jumped up in a bush when I imitated the alarm note of the Abert Towhee, and which later uttered a few calls during a vociferous territorial dispute between two pairs of Abert Towhees. The third is the scattering of a group of Abert Towhees from a feeding station when a Canyon Towhee voiced alarm.

Because of their extreme rarity and importance, the actual conflicts between the two species of brown towhees will be described. The most important occurred on October 23, 1957, at the northwestern corner of the study site at San Xavier Reservation, and I quote from my field notes. "Here is a pair of *aberti* at edge bosque and one flew swiftly out to mesquite bush in field and peeped, then its mate joined it low in same bush. Meanwhile the pair of *fuscus* began to call "shedap" out there near them. Then the pair of *fuscus* was inside bosque slowly hopping after *one* of the *aberti*. The *aberti* (as far as I could tell was the only one responsible for this sound) kept up a "cut-cut-cut-cut" chatter, grating, harsh, threatening. The *fuscus* both kept up faint "shedap" calls which seemed to be their belligerent note. Of the two *fuscus* one was more aggressive, perched

higher (above the *aberti*) and followed within 6 to 8 inches of the *aberti* and actually fought the *aberti,* driving him to the ground; the other stayed at same level as *aberti* (below its mate), followed a foot or more behind, didn't peck the *aberti,* but acted exactly as if *supporting every movement of its mate*—backing it up, *literally.* The *aberti* retreated from them slowly and grudgingly—it made a more terrorizing picture than *fuscus*: all puffed up, head retracted, scapulars raised up off wings—would turn and face antagonists. Up in the bush, when the actual fight came, it was rushed from above, pecked and clapped with wings (on purpose? or just because *fuscus* fluttered?) and thus fell head down—upside-down a couple feet through bush to the ground. But it recovered and the slow progressing chase continued, down next gully, up another bush, then all three to base mesquite edge field and *aberti* sidled off N along bank and seemed to join a 2nd. . . . the two *fuscus* had done some squealing also." A half hour later, in the field, there was an outburst of calls among the same birds, then a short *cut-cut-cut* from the Abert Towhee and squeals of a Canyon Towhee as it again chased the Abert, but this was all over in a few seconds. These birds (at least the same Canyon Towhees) were subsequently banded but could not be found again for more than a year, and because it was thought they had succumbed, the study area was shifted southward. Actually, they had moved 300 yards to an irrigated farm, where at least one of the original pair of Canyon Towhees, and possibly the same Abert Towhees, were seen again on February 19, 1959. There a single Canyon Towhee flew at the pair of Abert Towhees and chased one as they arrived at a corral, whereupon the banded male Abert Towhee, suddenly stimulated to aggressiveness, chased off first the Canyon Towhee, then a Pyrrhuloxia, as he went from bush to bush and post to post of the corral in short flights, spreading his tail at each landing as he threateningly patrolled the corral area.

The remaining conflicts from the principally-studied portion of the area do not convincingly bear out any deep-seated antagonism among the birds. On December 17, 1958, a Canyon Towhee squabbled in a bush when an Abert Towhee suddenly landed there. On February 11, 1959, an Abert Towhee chased a Canyon Towhee out of a tree where it had sat preening. On April 9 a Canyon Towhee landed near what seemed to be an Abert Towhee in a tree and uttered strident territorial calls at it. Finally, on April 21, 1959, while two or three pairs of Abert Towhees and three Canyon Towhees were feeding together on seeds placed near a well, there was an attack by one of the Aberts upon the female Canyon Towhee whose territory they were in. If this was the local owner of the same Abert territory, then the antagonism had subsided by May 20 when the two pairs that "owned" this territory on behalf of the species *fuscus* and *aberti,* respectively, arrived at the well simultaneously to drink at dusk. A few minutes before there had been vicious fights there among pairs of Abert Towhees that were attempting to drink.

In view of the overwhelming abundance of records of amicable relations between the two species, it seems necessary tentatively to regard the serious conflicts among the northwestern birds as exceptional, not representative, and due to peculiar conditioning among those particular individuals. If this is actually true, then we may infer that on the whole, the two species do not sense each other as competitors.

Pair formation and reinforcement.—In view of the similarities between Abert Towhees and Canyon Towhees, what behavioral differences serve in species recognition by which appropriate matings are assured? There is of course no question that the two species are reproductively isolated in nature. Nor has there ever been observed an attempt of one species to court or to mate with the other. For an explanation we must look to minor differences in the homologous and identically-used calls and behavior patterns involved in pair formation. First, let us examine the pair bond and its maintenance,

a description of which applies equally well to both species. The actual start of a new pair bond has not been observed, and it is not likely to be seen save by a stroke of luck. The way it must happen can only be inferred from the rituals by which it is maintained and strengthened throughout the year. Pairs persist normally for the life of the mates and exist only in conjunction with the holding of a territory. All year the male shepherds the female, watching for danger, and jumping up into a bush to stand guard at the approach of a person, while she feeds unconcernedly. While thus on guard he usually anticipates her progress, and when she flies he will arrive simultaneously at her destination. There they will engage in a pair-reinforcement duet of squealing calls, often accompanied by certain exaggerated postures, during which the male usually perches higher than the female. This is the basis for sex recognition, necessary in these species which have no sexual dimorphism in coloration. When the members of a pair become separated, as they frequently do when foraging, they begin to give a locative note, a slight *seee*, and when they rejoin, they do so to the accompaniment of the "squeal duet."

Several new pairs (6 Abert, 3 Canyon) were formed before the 1959 breeding season and period of singing began; therefore we may postulate that song is not vital to pair formation and that a new pair might form at any season, but especially in early spring, as follows. A lone bird stationed on its own permanent territory (in marginal habitat for young birds) gives a *seee* call occasionally (a sign of a lone individual or one separated from its mate) and engages in a "squeal duet" with a responding bird. From their relative positions sex recognition is achieved, and if the new bird is single and of the opposite sex, a pair is in the making. The "squeal duets," very strident at first, in time taper down to very light perfunctory renditions, especially for the Canyon Towhee, as the mates become used to each other. Presumably an early stage of a new pair bond was exemplified by an immature male which moved a quarter of a mile to a new locality and was seen there squiring an unbanded mate with utmost solicitude. When I walked between them, they went in different directions. Upon rejoining (the female flew a long distance swiftly to him), the male apparently failed to recognize her and attacked her instead of performing the necessary ritual. Previously he had threatened and chased her in a tree, and it would seem that because of the newness of his pair bond he acted upon conflicting drives, each temporarily gaining ascendency: intolerance of the close approach of another bird *versus* attraction to the mate.

During the breeding season unmated males on territories (3 Abert, 3 Canyon) sang persistently. Males whose mates were carried off in cloth bags for weighing and banding (1 Abert, 1 Canyon) also sang temporarily, but singing stopped when the pair was reunited. In addition, male Canyon Towhees (two out of four pairs) sang while their mates were incubating. An Abert Towhee, whose mate was unfortunately injured in a net and had to be killed, was singing two days later (April 14). He later gained a mate for a few days (April 16–21) during which he did not sing but engaged in loud "squeal duets" with her, and finally he was found alone and singing again (April 28 to May 5). This is the only singing male in my experience that has gained a mate even temporarily, for usually there are no unattached un-landed birds left at the commencement of the breeding season, and the singers themselves may succumb (1 Canyon Towhee) possibly because of their vulnerability to predation while upon an exposed song perch. Thus song in these contexts is the male's announcement that he is on a territory and is without a mate (for the moment at least), and we may assume that as in most songbirds it is attractive to the female. A pair therefore could be formed by appropriate rituals upon the entrance of a female into such a singing male's territory.

The aspects of this hypothetical schedule of pair formation which at present are known to differ in the two species are: (1) the *seee* call, (2) the "squeal" of the pair-

reinforcement ritual, (3) the song, and (4) the coloration of the birds. This study has not yet progressed to the analysis of recorded vocalizations (which will be necessary in analyzing annectant populations of *Pipilo fuscus*) but it is hoped that in view of the simplicity of the calls of towhees, a recourse to naive syllabifications will not be condemned. The *seee* call of the Abert Towhee is quavering and inflected; that of the Canyon Towhee is even, like the similar note of the Rufous-crowned Sparrow. The "squeal" of the Abert Towhee is a laughing *seee-squeal-ha-ha-ha* or *squeal-cha-cha-cha*, whereas that of the Canyon Towhee is a more even and subdued *squeal-squeal-currrrrr*. Although the Abert Towhee's song is merely an accelerating series of its ordinary call note, *peep*, often terminating in coarse warbled phrases like the song of a Tolmie Warbler (*Oporornis tolmiei*), that of the Canyon Towhee is a pleasant musical jingle of many varieties, consisting of repeated musical notes or phrases like the songs of Oregon Juncos (*Junco oreganus*) and Cardinals. In coloration, the two species differ most noticeably about the head; the prominent whitish bill of the Abert Towhee is conspicuously set off by a surrounding mask of black feathers, and the throat and chest are concolor. The Canyon Towhee presents in front view a light face, narrow borders to the throat, and a single blackish spot on the light chest. These then are the most conspicuous differences, which effect appropriate matings; there are others of course, such as posture and proportions; mannerisms during the pairing rituals are not yet well enough known in the Canyon Towhee to permit comparisons.

AREAL INTERRELATIONS

Territory.—There are many perplexing problems concerning territoriality in these towhees which are still being investigated. For instance, in the rainy spring of 1958 there was conspicuous vocal territorial advertisement by males of both species at dawn during late winter and the spring nesting season, which began in March, whereas in the drought of 1959 there was no such advertisement, even when the largely unsuccessful nestings began in April. In the season of 1959, territorial boundaries were fought over and announced by "squeal duets" during the daytime. Perhaps the role of the "squeal duet" had been overlooked in 1958, but in that year the populations became so thin at nesting time (figs. 1*a* and 2) that there was little contact between adjacent pairs, and two pairs of Abert Towhees even raised their second broods in areas formerly held by birds which disappeared.

Territories of established pairs in each species are maintained all year. In fall and winter, however, the pairs wander over a larger area than the contracted nesting territory, and they then tolerate within what will become the nesting territory all other members of their species, which fall into the following categories: (1) roving unpaired immatures, (2) immature pairs which have established themselves in marginal habitat, (3) sedentary unpaired adults, and (4) neighboring established pairs. This system provides for thorough acquaintance with the established territory and its places for concealment and safety by a group of individuals which may be called the supernumeraries or the "floating population." They are thereby well qualified to become successful replacements for deceased members of established pairs. Six immature Abert Towhees and four immature Canyon Towhees "stepped up" into the landed class in that manner in 1959. Some of the latter, however, represented pairs on new territories.

At the onset of nesting there is no further encroachment, at least by established pairs, without serious repercussions (table 2) consisting of threatening "squeal duets" by the two opposing pairs at the mutual boundary or segment of disputed land which often leads to fighting and chasing. At least in the nesting season of 1958 and the weeks preceding it, there was vocal announcement of the territory for a few minutes at dawn by

males of established pairs, in the following manner. The Canyon Towhees would sing from high perches within or around the boundaries of their territories; each male Abert Towhee, upon awakening, would utter loud call notes (*peep*) while rushing from tree to tree around the boundary.

As shown in figures 1 and 2 the territories of Abert Towhees were smaller than those of Canyon Towhees, and at San Xavier Reservation they were "anchored" in the bosque, whereas those of Canyon Towhees centered in the fields. That is to say: a typical Abert Towhee territory consisted of bosque (or a substantial patch of trees along a hedgerow) plus the adjacent one side of a field; the larger Canyon Towhee territory, on the other hand, included the bosque edge of two or three sides of a field. Most important for our discussion, however, is the fact that the territories of the two species were superimposed upon each other and thus broadly overlapped, contrary to the exclusiveness expected among competing sibling species.

Nest placement.—The most crucial evidence that denies any interspecific areal accommodation (spacing) is the placement of nests, whose locations epitomize the fact of territorial deployment within each species. As shown in figures 1 and 2, nests are separated in accordance with advertised and defended territories, at no less than 80 yards between nests of neighboring Abert Towhees and 140 yards between those of Canyon Towhees. But they are placed entirely without reference to nests of the other species, so that simultaneously active nests of the two were as close together as 10, 25, 32, 45 and 47 yards. There was no species difference in nest sites at Sabino Creek; at San Xavier Reservation both species built in elders along hedgerows, but so far no Canyon Towhee nests have been found in the bosque. Strangely, one nest of each species at San Xavier Reservation was built in tumbleweeds hanging up against fences.

CONCLUSIONS ON INTERRELATIONS IN AREA OF OVERLAP

In limited river-bottom areas at Tucson there is habitat suitable for occupancy by resident populations of Abert and Canyon towhees. (The principal local habitat of the latter is rocky desert slopes.) The two similar species utilize this environment in the same way; the population of one is superimposed on the other with no striking ecologic, behavioral, or areal accommodations made by one species for the other. Despite the competition that would be manifest if the food supply and nesting sites became curtailed, they exist in numbers and display behavior characteristic of their occurrences alone in other environments. In fact they exist for the most part as if the other species were not there! These two sibling species of brown towhees avoid competition over the vastly greater portion of their distributional ranges by choosing entirely different habitats.

COMPARISON OF CALIFORNIA, ABERT, AND CANYON TOWHEES

Some of the better-known attributes of Abert and Canyon towhees are tentatively compared with those of the California Towhee in table 3. It is hoped that the postures and rituals of aggressive and sexual encounters will become better known for the first two, so that the comparison may be rounded out to include these fascinating aspects of behavior so easily observed in the California Towhee. Such behavior, for example, includes the sudden grasping of twigs, as symbols of nesting, by the soliciting female. Table 3 points up the remarkable similarity in voice and certain aspects of behavior and appearance between the Abert and California towhees. Behavioral evidence thus fully substantiates the conclusion of Davis (1951:98–99), based on distributional, morphologic, and paleoecologic considerations, that the Abert Towhee arose from the California Towhee, after the latter had become geographically isolated from the Canyon Towhee. Presumably the evolution of the Abert Towhee, alone in its riparian environment, was rapid (Davis, 1951:100). Differentiation was confined to those traits enhancing its re-

productive isolation from the California Towhee and those favoring its survival in the new habitat. Such changes would be the distinctive quality of the call note and the "squeal duet," the acquisition of the black facial mask, and the strong attraction to dense river-bottom woods. Other traits, in the majority, would have remained relatively unchanged, to preserve to this day the many attributes of the parent stock.

Of the three, the Canyon Towhee is set off by its thrush-like demeanor. Nowhere

Table 3

Comparisons of Brown Towhees

In brackets are equivalent terms from Quaintance (1938, 1941)

	P. aberti	*P. f. petulans*	*P. f. mesoleucus*
Proportions	Long tail	Long tail	Shorter tail
Coloration	Dark	Dark	Light
Stance on ground	Horizontal	Horizontal, tail droops, dumpy	Erect, graceful
Head feathers	Compressed	Compressed	Raised
Demeanor	Noisy, bold, but usually concealed in bosque	Noisy, bold, in open, a despot	Quiet, unobtrusive, secretive
Foraging	Long time in one spot	Long time in one spot	Keeps moving
Eggs	Pale blue, black dots at large end	Pale blue, black dots at large end	Pale, heavily marked with brown and purple
Call note	Sharp *peep*	Sharp *chip* similar to *aberti* [*tsip*]	Rough *shedup*
Function of call note	Alarm, excitement, territorial announcement at dawn	Alarm, excitement, territorial announcement at dawn	Alarm, other excitement
Song [male song]	Accelerated series of call notes ending in warble like Tolmie Warbler	Accelerated series of call notes ending in warble like Tolmie Warbler	Musical series of notes or phrases, even tempo, like junco or Cardinal
Function of song	Signifies absence or lack of mate	Signifies absence or lack of mate	Territorial announcement at dawn, or signifies absence or lack of mate
Locative note	Quavering *seee*	*Seee* with slight quaver [*tssp*]	Even *seee* like Rufous-crowned Sparrow
Alarm note near nest with young	*Tic*	?	*Tic* or *sip* like Chipping Sparrow
Pair-reinforcement duet [mate call]	*Squeal-cha-cha-cha*	*Squeal-squeal-currrrrr* [*tss' tss' tss' tsurr tsurr tsurrr*]	*Squeal-squeal-currrrrr*
Nest	Broad strips of bark	Fine stems	Fine stems
Fledglings	Move rapidly	Stationary	Stationary
Habitat	Dense riparian woods	Open ground near bushes	Open ground near bushes

in the literature has this been so well appreciated as in the excellent account by Batchelder (1885:237). A person acquainted only with the California Towhee and with the fact that it and the Canyon Towhee have the same scientific name would think his following remarks preposterous! "Here one would sometimes be seen running along and then stopping, somewhat like a Robin on an earthworm hunt. Their run really consists, however, of a series of rapid hops. There is much that is Thrush-like about their air and motions,

and if seen from behind one might almost be mistaken for a Robin, its form and attitudes are so similar, though it does not stand as upright as a Robin very often does. As a rule they kept on the ground but now and then they would get up in a bush or even in a low tree, but as soon as a Towhee saw he was attracting attention he immediately shifted his position or retired silently with a swift low flight to some safer place." Batchelder also noted the strong attachment of the birds for adobe dwellings and abandoned farm houses; he correctly ascertained their social organization and persistent pair bond.

The reader unacquainted with the conclusions of Oberholser (1919), amplified by Davis (*op. cit.*), doubtless wonders why the Canyon and California towhees are classified in the same species. The explanation lies in the occurrence on the cape of Baja California of a population morphologically similar to the Canyon Towhee, yet which intergrades northward with the California population. It will be of great interest to see if the voice and behavior of these birds from Baja California agree with the concept of relationships worked out morphologically. (Since the foregoing was written, I have found *P. f. albigula* of the Cape district to be identical in behavior and voice with the California Towhee.) Meanwhile, it is evident that the Canyon Towhee of Arizona, in common with all the populations with which it is linked by intergradation throughout México, is certainly the ecologic counterpart of the California Towhee. Like the similarity in habitat, nest construction and the details of color pattern (differing mostly in degree from the California bird), those vocal (excepting song) and behavioral traits which should be important in pair formation are similar in the two forms, in fact identical as far as I can tell in the case of the all-important "squeal duet." These are among the crucial similarities which keep open the door to interbreeding among the populations. These behavioral facts strengthen the idea developed from other evidence that the California and Canyon towhees are conspecific, although it must be admitted that it is a strain upon our species concept and that few if any other North American species possess such qualitatively different subspecies as these.

SUMMARY

Pipilo aberti and *Pipilo fuscus mesoleucus* overlap in mesquite river-bottom woodland near Tucson and utilize this wood and its edges essentially in the same way. *Pipilo aberti* is more confined to the interior of the woods than is *P. f. mesoleucus*; the former probably does more scratching for its food than the latter. There is little antagonism between the two species, their territories are superimposed, the nests can be as close together as 30 feet, and they behave as if the other species were not there. *Pipilo aberti* resembles *Pipilo fuscus* of California in most traits except those involved in pair formation and ecologic preference which traits account for its reproductive isolation. Although *P. f. mesoleucus* differs in many respects from *P. fuscus* of California, its similarity in ecology and those other behavioral and vocal traits necessary to keep open the capability of interbreeding tend to substantiate the conclusion of Oberholser and Davis that they are subspecies.

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Department of Zoology, University of Arizona, Tucson, Arizona, May 28, 1959.

FROM FIELD AND STUDY

Failure of Estrogen and Prolactin Treatment to Induce Brood Patch Formation in Brown-headed Cowbirds.—It is known that cowbirds and other birds practicing brood parasitism (Miller, Scientific Monthly, 62, 1946) fail to develop brood patches (Davis, Wilson Bull., 57, 1945: 190). Since experiments by Bailey (Condor, 54, 1952:121–136) have indicated that brood patch formation in passerines depends on the synergistic action of estrogen and prolactin, the absence of a brood patch in the Brown-headed Cowbird (*Molothrus ater*) could be attributed to (1) insensitivity of the skin of the abdominal and breast areas to estrogen and/or prolactin, (2) insufficient production of one or both of these hormones, or (3) a combination of both factors. A deficiency of estrogen seems unlikely, and attention centers on prolactin, the pituitary hormone which also induces broodiness and other parental behavior in pigeons and chickens, since inadequate production of this hormone might also be an important factor in the development of the behavioral peculiarities of parasitic avian species.

In the course of studies on the behavior of cowbirds, their response to large doses of these hormones was tested in the following experiment performed on captive birds in the Biology Laboratory Building of the University of Texas, in Austin. On April 30, 1959, 3 mg. pellets of estradiol (Progynon, Schering) were implanted subcutaneously in the necks of four adult females, four adult males, and a bilaterally castrated adult male of *Molothrus ater*; and a pellet was also implanted in an adult male domestic Canary (*Serinus canaria*). Seven days later, the Canary had a defeathered, highly vascular, and moderately edematous brood patch, but the cowbirds exhibited no response. From June 23 through July 1, two female and one intact male estradiol-implanted cowbirds were given daily intramuscular or subcutaneous injections of 50 I.U. (as 0.05 ml. of aqueous solution) of prolactin (Panlitar, Armour), the potency of which was confirmed by the standard pigeon crop-sac assay method. At the time of prolactin treatment, the estradiol pellets were still visible through the neck skin. No defeatherization, increase in vascularity, or edema was noted in the cowbirds.

Working with fringillids, Bailey (*op. cit.*) obtained complete brood patch formation with estradiol treatment alone and provided experimental evidence suggesting that estrogen acts to induce secretion of prolactin by the pituitary. His experiments with hypophysectomized individuals suggest that estrogen initiates the vascular response, while prolactin is responsible for defeatherization and edema.

The present work would seem to indicate that the skin of the abdominal and breast areas of the Brown-headed Cowbird is insensitive to estrogen and prolactin. Recently, E. O. Höhn (Nature, *in press*) has shown that the pituitaries of breeding Brown-headed Cowbirds produce prolactin in amounts comparable to those produced by pituitaries of breeding female Redwinged Blackbirds (*Agelaius phoeniceus*), a related, non-parasitic species of similar size in which females have brood patches. Höhn's work nicely supports the conclusion suggested by the present study, namely, that the absence of a brood patch in parasitic cowbirds is attributable not to a deficiency of prolactin or estrogen but, rather, to a failure of tissues in the brood patch region to respond to these hormones.

It would be interesting to compare the behavior of hormone-treated and untreated female cowbirds. One of my females treated with estradiol, but not with prolactin, repeatedly manipulated straw and small twigs, defended a nest-shaped wire feeding cup against another female, and made brief nest-molding movements while sitting in the cup. There are several reports of female Brown-headed Cowbirds feeding juvenal cowbirds (Bent, U. S. Nat. Mus. Bull. 211, 1958:441–442). With proper hormone treatment, it is possible that other latent nesting and parental behavior could be induced in *Molothrus ater*.

This study was supported by the National Science Foundation (Grant G–7121).—Robert K. Selander, *Department of Zoology, The University of Texas, Austin, Texas, November 7, 1959.*

Elegant Tern and Royal Tern Nesting in California.—In the spring of 1959 the Elegant Tern (*Thalasseus elegans*) and the Royal Tern (*Thalasseus maximus*) nested on a dike at the salt works at the south end of San Diego Bay, San Diego County, California. Heretofore these species have not been known to nest in California. Evidently they have colonized the San Diego area from the breeding colonies that have existed for many years 350 miles to the south in central Baja California, as at Scammons Lagoon.

The tern colony was first found on May 2, when five nests of the Elegant Tern were noted, each with one egg. On May 6 there were seven nests; May 9, 14 nests; May 12, 20 nests; May 16, 27 nests:

May 20, 30 nests; and May 23, 31 nests. On May 20 two of the nests held two eggs each. The first young were noted on May 27 and on June 3 there were seven young which were banded.

On May 12 among the Elegant Terns and the associated Caspian Terns (*Hydroprogne caspia*) a Royal Tern was found. It was seen to settle on an egg between two nests of the Caspian Tern that were only 18 inches apart. Immediately the two Caspian Terns began to peck at the Royal from their nests. We could plainly see the speckled crown of the Royal Tern against the black crowns of the Caspians. We sat and watched them for 20 minutes, by which time they all had quieted.

On May 16 the Royal Tern was not seen, and on the 20th the egg was found to be cold and apparently abandoned. It was collected, as well as two sets of Elegant Tern eggs. One adult male Elegant Tern was also collected (no. 30155 San Diego Soc. Nat. Hist.).

On June 6 all eggs and two banded young Elegant Terns had been destroyed by boys and thrown into a clump of salicornia. We hope the other five young Elegant Terns escaped the vandalism.—Fred Gallup and Bernard H. Bailey, *Escondido, California, June 8, 1959.*

Occurrence and Breeding of the Golden-cheeked Warbler in Dallas County, Texas.—Since the spring of 1957 a number of reliable local observers have reported the occurrence of the Golden-cheeked Warbler (*Dendroica chrysoparia*) in the cedar brakes near the town of Cedar Hill in southwestern Dallas County, Texas. An adult male (Dallas Mus. Nat. Hist. no. 5154) was collected on May 12, 1958. This specimen extends the known range of this warbler about 70 miles to the north and east of the range as defined in the A.O.U. Check-list (1957).

A concerted effort was made from 1957 to 1959 to discover nests or other evidence of breeding of this warbler in the Cedar Hill area. No nests have, as yet, been found, but on May 11, 1959, two separate pairs of adults, each accompanied by four fledgling young not more than a few days out of the nests, were discovered. One of these fledglings (no. 5167) was collected, establishing the breeding of the Golden-cheeked Warbler in the Cedar Hill area.

The Cedar Hill district is a relatively isolated area of habitat surrounded by the blackland prairies, but it agrees in general characteristics with the breeding habitat of this warbler in the Edwards Plateau region (Bent, Bull. U. S. Nat. Mus., 203:316–321).

In May of 1959 investigations were begun to determine the occurrence and possible breeding of the Golden-cheeked Warbler in other areas of suitable habitat in north-central Texas. On May 22, 1959, an adult female (no. 5171) was collected in southwestern Johnson County, Texas. This location is approximately 42 miles southwest of the Cedar Hill area.

These records suggest that where habitat conditions are suitable, the Golden-cheeked Warbler may be expected in other areas of north-central Texas.—Hal P. Kirby, O. M. Buchanan, Jr., and F. W. Miller, *Dallas Museum of Natural History, Dallas, Texas, September 16, 1959.*

The Honeycreeper Dacnis albiventris in Brazil.—In the course of field work on the upper Rio Cururú, an eastern tributary of the Rio Tapajós, in Pará, Brazil, our party took two specimens of the honeycreeper *Dacnis albiventris*. According to Hellmayr (Cat. Birds Am., pt. 8, 1935:283) the range of this species is chiefly in eastern Colombia. It also occurs in eastern Ecuador and northeastern Perú and in the Amazon territory of Venezuela (Phelps and Phelps, Lista Aves Venezuela, 2, 1950: 273). Pinto (Cat. Aves Brasil, 2, 1944) does not list the species for Brazil and no reports of its occurrence have been received subsequent to the appearance of his check-list (Pinto, *in litt.*, 1959). The Cururú area is some 700 miles from Colombia and Venezuela and thus the range of this upper Amazon type of bird is extended far to the eastward. Other species belonging to the upper Amazon fauna were also taken in the Cururú area such as the hummingbird *Polyplancta aurescens* and the trogon *Pharomachrus pavoninus*.

The two specimens of *Dacnis albiventris* were taken on the same day, August 9, 1957. One is an adult male, the other an immature male. In the latter the dark blue and black feathers of the mature plumage were only beginning to appear. Their weights were 11.0 and 11.5 grams, respectively, the skulls were fully ossified, and the testes were not active. Both birds were part of a flock of small birds which was active in the top of the trees of the forest, the "mata geral," about thirty feet from the ground. Another species of honeycreeper, *Cyanerpes caeruleus*, was part of the flock. Also in the group was the furnariid *Microxenops milleri*, a rare bird in Brazil, and usually found in the upper Amazon and on the north side of the river.

Alexander Wetmore kindly made the identification of the specimens at the United States National Museum. I follow Zimmer (Am. Mus. Novitat. No. 1193, 1942:2) in using the name *Dacnis* rather than *Hemidacnis*.—HELMUT SICK, *Fundação Brasil Central, Rio de Janeiro, Brazil, August 5, 1959.*

Roadrunner a Predator of Bats.—On two occasions in the summer of 1959, the author observed a Roadrunner (*Geococcyx californianus*) killing and eating Mexican free-tailed bats at Davis Cave, Blanco County, Texas. On June 15 a bird picked up two bats from a group of baby bats that had been placed on the ground about fifteen meters from the cave entrance. These animals had been removed from the cave floor where they had fallen. After the second bat was consumed, the bird was accidently frightened away. On July 28, a Roadrunner was surprised at 6:00 a.m. about five meters from the cave entrance with a bat held in its beak.

It was not necessary for the Roadrunner to have entered the cave to have obtained the bat. On many occasions, particularly when the young bats are beginning to fly in July and August, they crawl and hang to rocks outside the entrance to the cave. Many of these animals after falling near the mouth of the cave or colliding with a wall, ceiling, or another bat at flight time, are able to take off again, but some remain for some time outside the cave and are thus easy victims for various predators.—CLYDE F. HERREID II, *Laboratory of Comparative Behavior, School of Hygiene and Public Health, The Johns Hopkins University, Baltimore, Maryland, August 25, 1959.*

Black-and-white Warbler and Purple Finch in New Mexico.—On December 30, 1957, I collected a Black-and-white Warbler (*Mniotilta varia*) along the Gila River near the town of Cliff, Grant County, New Mexico. The bird proved to be a male, with an incompletely ossified skull. It had only a slight amount of fat and weighed 9.8 grams. During the fifteen minutes or so that it was under observation it fed on and near the ground under some large cottonwoods, foraging apart from several Audubon Warblers (*Dendroica auduboni*) and Bridled Titmice (*Parus wollweberi*) which fed in the same trees.

On January 2, 1958, I discovered a highly plumaged male Purple Finch (*Carpodacus purpureus*) feeding on the seeds of mountain mahogany (*Cercocarpus montanus*) with a number of Cassin Finches (*Carpodacus cassinii*) five miles northwest of Silver City, Grant County, New Mexico, elevation 7000 feet. It weighed 22.8 grams and had little fat. The specimen has been deposited in the University of Michigan Museum of Zoology where I have identified it as the western race, *C. p. californicus*. The warbler specimen is in my collection at New Mexico Western College. I have found no previous New Mexican record for either of these species.—DALE A. ZIMMERMAN, *Department of Biology, New Mexico Western College, Silver City, New Mexico, September 20, 1959.*

King Eider at Monterey, California.—On February 3, 1958, we saw a King Eider (*Somateria spectabilis*) in the harbor of Monterey, Monterey County, California. It was first seen swimming among the moored boats near the United States Coast Guard Pier. Later we saw it perched on a mooring raft in the same area, about 150 yards from shore, where we were able to observe it with the aid of a 20×60 telescope for about an hour. It was in the brown plumage of a female or of a first-winter male. The head-and-bill profile, together with the diagnostic patterns of feathering and processes of the bill, could be clearly seen.

The bird was subsequently watched on a number of days, sometimes for prolonged periods, often at close range. It was always between the Coast Guard Pier and Municipal Wharf No. 2, an area not more than about a quarter of a mile square. Much of its time was spent sleeping and preening while perched on the raft. Its presence was not noted after March 16, 1958.

On several occasions the King Eider was seen swimming and diving close to the sides of some of the boats at anchorage. Once, on February 3, it "tipped up," in the manner of a dabbling duck, along side a boat, apparently feeding on green algae, or some other organism adhering to the hull. Harry C. Adamson writes that he watched the King Eider on March 1 as it swam and dove at a distance which was sometimes not more than 10 yards away. Each time it returned to the surface it held in its bill a pale flesh-colored starfish, estimated to be about four or five inches across. The bird "seemed to 'chew' the starfish into smaller pieces" which were then quickly swallowed. "Some of these pieces were dropped in the process of 'chewing' and quickly picked up before they could sink."

Echinoderms are listed among the animal items eaten by this species (Kortright, The Ducks, Geese and Swans of North America, 1943:320). Bent (Life Histories of North American Wild Fowl,

U. S. Nat. Mus. Bull. 130, 1925:114) includes starfish among various marine organisms which the species is "said to eat."

On March 21, 1959, Holmes, Roger T. Peterson, and others, saw another King Eider, this time on ocean waters at Cypress Point, about five miles from Monterey. Although this bird remained for most of the time rather far from shore, often in the company of a group of Surf Scoters (*Melanitta perspicillata*), it occasionally approached to within 30 yards of the beach. The bird was "a young male . . . just going into adult plumage . . ." and having the "fundamental pattern of white chest and dark back." The short bill, as compared to *Somateria mollissima*, was "fairly orange or deep chrome yellow, but the bird had not yet developed the full frontal shield . . ." (Peterson, in a letter). The forehead profile, however, was abrupt, and not sloping, as in either *S. mollissima* or in the Spectacled Eider (*Lampronetta fischeri*). The bird was seen again in the same area of water on March 22 and 23 and was last seen there by Williams on March 26, 1959.

A King Eider was again seen on June 24 and 25, 1959, in the same section of the harbor of Monterey in which the first eider was watched during February and March, 1958. Its presence was reported first by Hubert Arnold. Like the eider of March, 1959, it was a sub-adult male, possibly the same individual?, with orange-yellow bill and characteristic head profile, but lacking the frontal shield. The neck and sides of the head were white, irregularly mottled and blotched with grayish, but the whitish line, which in adult plumage arches over the eye and extends down the neck, was distinctly outlined. When the bird turned its head upside down during preening, the forward-pointing V-mark on throat and chin showed faintly. Although no attempt was made to test the bird's ability to fly, flightlessness was indicated by the extremely worn condition of the primaries and secondaries, the latter appearing to be mere shafts without barbs.

The status of the King Eider in California, according to Grinnell and Miller (Pac. Coast Avif. No. 27, 1944:88), is that of a "rare straggler in winter from far north," being heretofore known from only "three definitely determined" occurrences in the San Francisco Bay area based on specimens taken between 1879 and 1933.—Laidlaw Williams, *Carmel, California,* and Richard T. Holmes, *Museum of Vertebrate Zoology, Berkeley, California, August 25, 1959.*

The Age of the Cave Swallow Colonies in New Mexico.—On July 23, 1930, a field party from the University of Kansas Museum of Natural History collected two Cave Swallows (*Petrochelidon fulva pallida*), at Slaughter Canyon, eight miles southwest of White City, Eddy County, New Mexico. These birds were fairly clearly from a nesting colony; the field notes of Harry C. Parker, one of the Museum party, read: "The boys got back from Slaughter Canyon with a story of a huge hole in the mountain side. . . . They also had two swallows. . . . The swallows live in the big cave, which goes several hundred feet straight down." The two specimens (KU 18028, 18029) were prepared as skins, identified as Cliff Swallows (*Petrochelidon pyrrhonota*), and have remained unreported until now.

Recently Kincaid and Prasil (Condor, 58, 1956:452) published the only heretofore known records of Cave Swallows in New Mexico, based on birds seen and specimens taken in 1952 and subsequent years at a colony in Goat Cave, eight miles southwest of the entrance to Carlsbad Caverns National Park, Eddy County. A reasonable implication of this report by Kincaid and Prasil, although not so stated by them, was that the colonization of southeastern New Mexico by Cave Swallows had taken place recently, perhaps owing to an extension of range paralleling the generally northward extensions of breeding range now known of several kinds of vertebrates of México and the American southwest. Such implication should be avoided in view of the specimens dating from 1930, 22 years antecedent to the erstwhile first records of occurrence in New Mexico. It is wholly possible that the age of the Cave Swallow colonies in New Mexico is only 29 years, but it is much more likely that the colonies have been established for a longer period of time, during which collectors did not look for southern "exotics" as far north as New Mexico.—Richard F. Johnston, *Museum of Natural History, University of Kansas, Lawrence, Kansas, September 25, 1959.*

The Rock Sandpiper, Another Northern Bird Recorded from the Cool Coast of Northwestern Baja California.—For several years I have been convinced that the Rock Sandpiper (*Erolia ptilocnemis*) migrates southward as far as the discordantly cool northwestern coast of Baja California, México, but inasmuch as the species had been reported as ranging no farther south than

northern California, I withheld any printed statement to that effect. Publication of the range extension is now prompted by the demonstration of the occurrence of this northern species in southern California (Small, Condor, 61, 1959:225).

On intertidal rocks in northwestern Baja California I have seen at close range, on at least three occasions, one or two sandpipers that seemed definitely referable to this northern species. They were medium-sized, rather chunky, and in flight exhibited conspicuous white wing bands but no white tail base. They were larger than Spotted Sandpipers and did not tip as that species does. Following are the more definite sight records, extracted from the notes made on our monthly surveys of coastal temperatures: (1) One bird at Papalote, a generally deserted fishing camp on the very cold southwestern shore of Punta Banda, at latitude 31° 43.4′ N, on April 27, 1952. (2) One bird between Punta Cabras and the point charted as Punta San Isidro but known to local residents as Punta Piedras Blancas, at latitude 31° 19.0′ N, on April 28, 1952. (3) Two birds at Santo Tomás Anchorage, at latitude 31° 33.3′ N, on August 8, 1952.

Each of these three localities is in an area wherein strong upwelling markedly reduces the inshore sea-surface temperature and renders the atmosphere along the rockbound shore cool and moist. Furthermore, during the winter of 1951–52, and in several preceding years, the coastal water temperatures fell below normal.

The Rock Sandpiper has not been reported from Baja California or elsewhere in México. The discovery of this northern species there closely parallels the recent southward extension of the known range of the Common (American, or Black) Scoter, *Oidema nigra* (Hubbs, Condor, 57, 1955:121–122, and 58, 1956:448–449). The far-southward occurrence of that species is further elucidated by the following additional observations, listed from south to north: three drakes, with one male Surf Scoter, in surf at tip of Punta Baja, at latitude 29° 56.9′N, on April 29, 1959; six resting and three diving, in surf, at mouth of Rosario Cañon (latitude 30° 09.8′ N), on May 27, 1957; eleven, mostly drakes, in three groups, well outside surf, between Socorro and Rosario, at approximate latitude 30° 12.2′ N, on May 27, 1957; three drakes in surf at same locality, on April 30, 1958; six, in surf at same place, on April 29, 1959; at least one, a drake, in surf, with Surf Scoters, at Punta San Isidro (= Punta Piedras Blancas), at latitude 31° 17.7′ N, on April 30, 1958; five females and one drake, in surf, between Punta Cabras and Punta San Isidro, at latitude 31° 19.0′ N, where one of the Rock Sandpipers was seen earlier; three drakes seen by me on the 1957 Christmas Census, on December 29, as they flew into San Diego Bay, California, low over the entrance, in early morning, on the flight course of multitudes of Surf Scoters; one drake, seen on surface of San Diego Bay entrance, at bow of ship, on June 20, 1959. The records for Baja California extend the known range of the Common Scoter southward about 65 miles and show that the species migrates as far as Baja California even in the unusually warm years of 1957, 1958, and 1959. The record of June 20 for San Diego strengthens the view that some scoters of this species summer over in the far southern reaches of its wintering range.

It now seems plausible to assume that any northern littoral bird that even rather rarely moves southward as far as the San Diego region will eventually be found in northwestern Baja California, where the coastwise temperatures, by reason of the greater upwelling of ocean water, are cooler than in southern California. I am finding this to be true of the marine fishes, generally.

In fact, nearly all northern coastal birds that are known to reach the San Diego region have now been taken or seen in Baja California. Two notable exceptions are the Oldsquaw (*Clangula hiemalis*) and the Mew Gull (*Larus canus*). Recent records of the Oldsquaw in southern California have been published by Morley and Sams (Condor, 60, 1958:337) and by Small (Condor, 61, 1959:302–303). It seems safe to predict that these species will be reported from south of the border.

Three other northern littoral birds have been reported from San Diego but not from México, but since these four have been recorded very rarely from about San Diego (Sams and Stott, Occas. Pap. San Diego Soc. Nat. Hist., No. 10, 1959:1–49) it seems unlikely that they will soon be seen by the few bird watchers in Baja California. These species are the Red-necked Grebe (*Podiceps grisegena*), recently reported from San Diego County by Stott (Condor, 61, 1959:299–300), Sharp-tailed Sandpiper (*Erolia acuminata*), and Common Murre (*Uria aalge*). The two other northern littoral birds that are included in the San Diego list, namely the Parakeet Auklet (*Cyclorrhynchus psittacula*) and the Horned Puffin (*Fratercula corniculata*), were found dead and may have drifted southward after death.—Carl L. Hubbs, *University of California, La Jolla, California, June 27, 1959.*

Condor Remains from Rampart Cave, Arizona.—Through the courtesy of the personnel of the United States National Park Service and particularly through the continued interest and efforts of Chief Park Naturalist M. B. Ingham, I have been afforded an opportunity to examine a small collection of bird remains from Rampart Cave, Arizona. This cave is situated on the south bank of the Colorado River in the Lake Mead National Recreation Area about fifty airline miles east of Boulder City, Nevada. Studies of associated mammal remains were made by R. W. Wilson and of plant remains, as represented in the abundant ground sloth dung, by Laudermilk and Munz. They indicate an age of latest Pleistocene and possibly a period of somewhat greater humidity than at the present. No traces of man have been reported thus far, although the cave is quite extensive and well protected. Extinct mammals include *Nothrotherium shastense*, a species of *Equus* and the small *Oreamnos harringtoni*. The ground sloth was by far the most abundant animal, its dung having accumulated to a depth of over 20 feet in places and it covered a floor area of 4700 square feet. Bird remains were taken at depths of 30 to 57 inches from test pits dug in the compacted accumulation which has leveled the floor of the cave.

The bird remains are contained in fourteen small packets. Two packets contain mere chips that are not determinable beyond the class Aves. One packet contains a fragment of the pelvis of a hawk not distinguishable as preserved from *Buteo jamaicensis*, although it could represent another buteonid species. All other packets contain fragments of condor bones that are assigned with a fair degree of confidence to *Gymnogyps californianus*, the California Condor. One coracoid is from a nestling bird. The size of the adult bones is fully equaled by those of a Recent bird from Sespe Canyon, California.

All bones except certain phalanges are highly fragmented, which fact I am inclined to ascribe to trampling by the ponderous ground sloths. Otherwise the bones are well preserved except for some rodent nibbling. Parts of condors represented include: carpometacarpus; phalanges one and two of digit two in the hand; the pollex; a claw with complete sheath of right inner toe; phalanx one of the right middle toe; left innominate with acetabulum; synsacrum; fragment of ulna with secondary papilla; coracoid of nestling.

So far as I am able to learn, this is the first time that condors have been reported from Arizona.

Subsequently additional material was separated from a collection of mammal and reptile remains from the cave stored since 1936. In this were found egg shell fragments seemingly of the Turkey Vulture (*Cathartes aura*), the tibiotarsus of a nestling Barn Owl (*Tyto alba*), and a perfect right coracoid of an Aplomado Falcon (*Falco femoralis*).—Loye Miller, *University of California, Los Angeles, California, October 13, 1959.*

Notes on Birds from Hart's Pass, Washington.—Hart's Pass lies at an elevation of 6200 feet in the eastern Cascade Mountains of northern Washington. This section of Okanogan County is included in the Pasayten District of the Okanogan National Forest, which was the subject of an ornithological report by Burdick (Condor, 46, 1944:238–242). Most of Burdick's records were from Monument 83 and Early Winters Ranger Station, north and southeast, respectively, of Hart's Pass. Apparently Burdick made only one trip to the pass and to nearby Slate Peak. Thus some recent field work at Hart's Pass has made it possible to augment Burdick's report.

I was at Hart's Pass from July 1 to 4, 1959. By this time much of the snow had melted from the large, open, south-facing meadows, making them very wet. Shaded and drifted areas, however, were still covered with snow up to a depth of two feet. Most of the forest floor was similarly snow covered. Nighttime temperatures dropped to freezing.

Ornithologists from Washington State University visited Hart's Pass in 1953, 1956, and 1957. I wish to thank Dr. George E. Hudson for information on the region and for the loan of certain specimens, reported below, in the Washington State University collection. I also wish to thank Dr. Alden H. Miller for offering critical comments on the manuscript.

Parus gambeli abbreviatus. Mountain Chickadee. This species was abundant near Hart's Pass in 1959, where I collected a pair on July 3. The female weighed 11.5 gm. and had a brood patch; the male weighed 12.2 gm. and had testes enlarged to 7 × 7 mm. A male collected on June 28, 1953, (WSU 53–179) weighed 12.1 gm. and had testes 8.5 mm. long. Burdick's (*op. cit.*) specimens from Monument 83 were assigned to *P. g. grinnelli*. In his review of this species, Behle (Condor, 58, 1956: 51-70) did not mention these birds, but referred to four specimens from nearby localities (Lost River,

Mazama, Twisp) as intermediate but "closer to *abbreviatus*." The three specimens reported here must be similarly designated.

Anthus spinoletta pacificus. Water Pipit. Burdick (*op. cit.*) reported this species present throughout the summer but had no evidence that it bred at Monument 83. In early July, 1959, pipits were common in the meadows above Hart's Pass and were most abundant where large areas of snow remained. Several were seen hovering in display flights. A male taken on July 2 had testes measuring 8 × 6 mm. and weighed 19.9 gm. Another male (WSU 53–175) collected on June 27, 1953, had testes 9.5 mm. long. The species almost certainly nests in these meadows.

Leucosticte tephrocotis. Gray-crowned Rosy Finch. Burdick (*op. cit.*) saw this species only at Pateros, in early June, 1942. On July 2, 1959, a flock of at least 25 birds, arriving in groups of three and four, settled near the road between Hart's Pass and Slate Peak, at about 6900 feet. A single male was obtained from this flock; it had testes 4 mm. in length, weighed 26.5 gm., and was moderately fat. This bird (Mus. Vert. Zool. 139886) is clearly referrable to the more eastern race, *L. t. tephrocotis*. The Rosy Finch normally found in the Cascades is *L. t. littoralis*. A specimen of this latter race was collected on July 4, 1953, at Hart's Pass. This bird (WSU 53–195) weighed 27.9 gm. and had testes 10 mm. long.

Jewett, Shaw, Taylor, and Aldrich (Birds of Washington State, 1953:612) describe *L. t. tephrocotis* as "apparently rare in Washington," and list but a few records of migrant and wintering birds in the eastern portion of the state. At several localities some individuals of *L. t. tephrocotis* winter with flocks of *L. t. littoralis;* at Clarkston, for example, the winter bird ratio was reported to be 1 to 19. It is possible that the bird taken at Hart's Pass in 1959 had been one of such a mixed flock and that it remained with the flock at the time of spring migration. This bird, apparently somewhat tardily approaching breeding condition, was some 250 miles from the breeding range of its race.

Passerculus sandwichensis nevadensis. Savannah Sparrow. This was one of the most common species in the meadows above Hart's Pass in 1959. A nest containing five eggs was found on July 2. The single specimen taken, a male with 11 × 6 mm. testes, clearly belongs to this race. The breeding range of this subspecies in Washington is given by Jewett *et al.* (*op. cit.*: 630–631) as the southeastern part of the state, although they suggest that it may breed "northward in the more arid portions of the Okanogan Valley." Indeed, Munro and Cowan (A Review of the Bird Fauna of British Columbia, 1947:218) consider the race to be a summer resident as far north as Okanogan Landing, British Columbia, in the same valley. The nesting of this arid-country form in a wet mountain meadow at over 6200 feet elevation is of interest. This specimen does not bear out the suggestion of Jewett *et al.* (*op. cit.*: 628) that breeding colonies of the Savannah Sparrow in the less arid portions of northern Washington might be *P. s. anthinus*.

Zonotrichia atricapilla. Golden-crowned Sparrow. Farner and Buss (Condor, 59, 1957:141) found two pairs of this species nesting near Hart's Pass in 1956, establishing the southernmost breeding record for the species. During my short visit in 1959 I was unsuccessful in finding any of these birds. Sporadic occurrence of a species colonizing an area peripheral to its normal range is probably to be expected.

Passerella iliaca olivacea. Fox Sparrow. This was an abundant bird at Hart's Pass in 1959 and Burdick (*op. cit.*) had reported it for nearby areas. A pair of birds was observed carrying food, presumably to nestlings, on July 3. Males obtained on July 1 and 2 had enlarged testes and weighed 26.6 and 28.3 gm., respectively. Burdick (*op. cit.*) had no specimens of the Fox Sparrow; my specimens confirm the presence of *P. i. olivacea* in this section of the Cascade Mountains.—Richard C. Banks, *Museum of Vertebrate Zoology, Berkeley, California, December 17, 1959.*

NOTES AND NEWS

The dates for the annual meeting of the Cooper Ornithological Society have been changed to May 5, 6, 7, and 8, 1960, with scientific sessions on Friday and Saturday, the 6th and 7th, in Los Angeles. The change was made to accommodate persons travelling to the meeting of the International Committee on Bird Protection scheduled a few days later in Japan.

A. Brazier Howell has recently made a special endowment contribution for the purpose of providing an award of $150 each year to the member of the Cooper Ornithological Society who presents the most meritorious paper at the annual meeting. The awards are limited to persons who do not at the time hold a doctorate degree in biological sciences. This excellent feature should be a particular inducement and aid to independent and beginning investigators. The Brazier Howell Awards will be made on the recommendation of a committee consisting of the editor of the Condor, the president of the Board of Governors, and the member of the local committee in charge of the scientific program of the annual meeting. It is planned that the award be made first in 1960. The Cooper Society is deeply grateful to Brazier Howell who has thus benefited the organization and who was the Society's first Endowment Secretary and as such, shortly after 1910, began the building of the endowment fund for the printing of special publications.

The index for volume 61 of the Condor was prepared by Jane R. Durham as a contribution in the interests of the users of the journal. The many persons in this category will be continually indebted to her for this aid.

The Council of the American Ornithologists' Union at the 1959 meetings in Regina authorized issuance of the first grants for research from the income of the Josselyn Van Tyne Memorial Fund. A sum of approximately $600 will become available at the end of the fiscal year, July 31, 1960. The Council assigned to the Research Committee of the A.O.U. the administering of these grants and it is hoped that the first recipient or recipients may be announced at the next annual meeting in Ann Arbor in August of 1960.

Any student of birds who has a special need for equipment, travel, assistance, or materials to further his research is invited to submit an application (10 duplicate copies) for a portion or all of the money available. This application should give a full description of the proposed research, the type of help that is required, when the money should be made available, and the background and training of the applicant. All applications must be received by June 1, 1960.—S. C. Kendeigh, *Chairman, Vivarium Building, University of Illinois, Champaign, Illinois.*

The small shrub *Daphne mezereum*, which is covered with a profusion of pink fragrant blossom in the late winter, has been favored by English gardeners since the time of Francis Bacon (about 1600), who mentions it in his Essay on Gardens. This plant has a widespread north-temperate distribution in the calcareous woodlands of the Old World. But just recently, the Greenfinch (*Chloris chloris*) has discovered the large seeds in the unripe fruits and will strip the lot, in a couple of days, in June. Since the shrub is doubtless also grown in many gardens in North America, the writer would be grateful to be informed whether any seed-eater there similarly has discovered the food source provided by these fruits, which is available early enough to be fed, pulped, to nestlings. It would also be of interest to know what species of birds eat the shrub's succulent fruit when red and ripe, and thus may serve to disperse the seeds.

In the case of the Greenfinch the new habit has now spread by cultural diffusion from the Pennine region, its center of origin, to most parts of the British Isles; it is now being watched for on the European mainland.—Max L. Pettersson, *Linnean Society, Piccadilly, London W.1, England.*

The year 1960 marks the fiftieth anniversary of the founding of the Los Angeles County Museum. One of the four organizations instrumental in the founding was the Cooper Ornithological Club. The Club's representative in this undertaking was the late Howard Robertson who was the guiding spirit of the Museum in its early days. The extraordinary subsequent growth of the Museum has now brought it to a position of international prominence. As part of the celebration of the anniversary, the new auditorium of the Museum has been named by the Los Angeles County Board of Supervisors in honor of Jean Delacour, the present director, and a member of the board of governors of the Cooper Ornithological Society.

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January 1, 1960

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